ENGINEERING NEWS

THE CAPE COD SHIP CANAL has advanced about seven-eighths of a mile during the past year. Only one dredge has been used and about 492,000 cu. yds. of earth have been removed. The canal is about 200 ft. wide at the top and 15 ft. deep. The general course is along the Monument river. It enters the main land from Massachusetts bay at Barnstable bay, and the outlet will be south of the peninsula at Black River harbor in the town of Bourne. About seven miles remain to be excavated. The project was begun in 1880, and the contract requires the work to be finished June 20, 1891; but it does not as yet appear likely to be fulfilled then.

"THE JORONADO AND EL PASO RESERVOIR AND CANAL CO." is the name of an organization now seeking a concession and privileges from Congress, and the bill is favorably recommended by the House Committee on Agriculture. The company proposes to build and operate storage reservoirs, canals and laterals to irrigate the desert lands of the "Joronado del Muerto" and the Messilla and Rio Grande valleys in Southern New Mexico. The company asks for the right to take water for this purpose from the Rio Grande river not further south than Ft. Seldon. The capital stock is not to exceed $10,000,000, without consent of Congress; and the sum of $25,000 is asked for surveys to be made under the direction of the Chief of Engineers, U. S. A., which sum is to be refunded within 5 years after the completion of the system.

A VENEZUELAN SYNDICATE has been formed in Paris, with the name and title of the "French Co. of Venezuelan Railways" for the construction of railways, the navigation of lakes, and other works of public utility in the republic of Venezuela. The syndicate consists of several well known engineering firms and includes some Belgians likewise. The company propose to begin their operations by the construction of a line between San Carlos del Zulia and Merida, the capital of the State of "Los Andes." The State of "Los Andes" lies immediately to the south of the great Lake of Maracaibo, which connects directly with the sea but penetrates inland some 130 miles. A new line of steamers will be established between San Carlos on the Escalante and Maracaibo, in connection with the new railway. It is hoped that the operations of this company may be widely extended. Merida lies at an elevation of about 5,300 ft. above the sea, which elevation is to be attained within a very short horizontal distance, but the conditions are favorable for a reasonably good location.

Mr. WILLIAM H. BURR, Assoc. M. Inst. C. E., formerly connected with the Vera Cruz Railway, the Panama Railroad and the Mexican National Railway has been appointed Chief Engineer and General Manager of the company abroad, and is now in this city for the purpose of initiating the business of the company.

THE RAILWAY SYSTEM OF SOUTH AFRICA is being extended. Arrangements have been made for building the line from Kimberly to the Zambesi, through Bechuanaland. Work will be commenced in May or June, and the contractors have to build up to latitude 25° during the present year, and to complete the line in three years.

THE PROPOSED BRIDGE OVER THE CLYDE at Glasgow is designed for one span of 460 ft. and provides for a clearance of about 115 ft. above the river surface. It would be provided with a roadway of 40 ft. wide and two footways of 10 ft. each; and as the ground is low on both sides, access to the bridge would be had by an inclined plane doubling on itself, on either side. The approaches would each be 2,000 ft. long with a gradient of 1 in 28. Mr. WM. ARROL, of the Forth Bridge, makes the proposition to build this bridge, to the Clyde Trustees.

THE DETROIT RIVER BRIDGE question is bringing to the surface some extraordinary bridge plans. The Peninsular Bridge Co. is said, by the *Free Press*, to have plans for a draw-bridge "with a 1,000 ft. opening," or more probably two openings of 450 ft. each. A second plan of the same company provides for a channel span of 1,000 ft. But both are practically "winter," or low-level bridges.

THE MANHATTAN BRIDGE, across the Harlem river at 181st St., New York, will probably be officially opened to traffic before the end of February next. The bridge as it now stands very nearly completed is an unusually handsome structure, and a most substantial piece of engineering construction. The title has been changed to the Washington bridge.

THE PEEKSKILL BRIDGE across the Hudson at Anthony's Nose is being pushed by a force of several hundred men, who are mainly at work on the foundations for the eastern tower. Granite is being delivered and the steel for the towers is reported as being "in the shop."

THE OLD WATERFORD BRIDGE, across the Hudson river between Lansingburg and Waterford, and for which a late correspondent gave 1803 as the date of erection, was not built until 1804, according to the Troy *Daily Press* of Jan. 24. That journal copies an advertisement of April 10, 1804, in the Lansingburg *Gazette*, calling for stone-masons to build the abutments and piers of this bridge, "work to commence May 5, 1804." The same *Gazette* also calls for assessments on the shareholders of the bridge of $2, to be paid March 24, 1804, and $3 to be paid April 23, 1804. The *Press* says the bridge was not covered until 1815.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a head collision Jan. 27, near Galion, O., between a double header fast stock train and a light engine on the New York, Pennsylvania & Ohio. The collision occurred on a bridge, and the three engines and some cars were wrecked. Five persons were injured, one fatally. The stock train had been sent out in five sections, and it was the last section which was wrecked. It was evidently another case of insufficient precautions for the safety of the different sections of train.——A triple rear collision occurred Jan. 28 on the Southern Pacific about 50 miles east of San Antonio, Tex.

BRIDGE AND TRESTLE ACCIDENTS are reported as follows: On Jan. 20 a freight train on the Northern Pacific went through a trestle near Spokane Falls, Wash. Ty., and 10 cars fell into a gap 70 ft. deep. A car was derailed near the trestle by the body of a tramp who fell from the train, and this car caused the wreck. The engine got across in safety. The trestle was of wood, and was the second highest on the road. It is reported to have been condemned as unsafe.——On Jan. 21 the temporary bridge built by the Georgia Pacific Railway across the Tombigbee river at Waverly, Miss., gave way, the piers having been undermined by a flood.

A REMARKABLE FREAK, although one for which there are not a few precedents, was performed by a saloon car on the Northern Railroad of New Hampshire on Jan. 23. As a train of 20 cars, drawn by two locomotives, was leaving the yard, the caboose car climbed a frog and left the rails. The bump threw off the conductor, who was standing in the doorway, and as the only other man in the car thought he had jumped, he was not slow in following the example. In a derailed condition the car ran *four miles* over the ties and across the high trestle at Lebanon. Striking the crossing near the Lebanon station, it again took to the track and ran to East Lebanon, where the train was stopped and the loss of the conductor discovered. The car was only slightly damaged.

DEATH FROM MINING EXPLOSIONS in England, for 1888, were only 43. This is the lowest record since 1851, when the number was first officially given. The lowest previous to 1888 was 65 deaths in 1884. The highest record in the past 38 years was in 1866, when 650 lives were lost by explosions; 360 of these being covered by the one casualty at the Oaks colliery.

ONE HUNDRED AND FIVE COLLIERIES are open in India, says London *Truth*; and in 1886 1,400,000 tons of coal were mined.

AN EXTINCT VOLCANO is said to have been struck by the Elyton Land Co., of Birmingham, Ala., in excavating for its 2,200-ft. water-works tunnel, through the Red Mountain. About 300 ft. from the west face of the tunnel the workmen encountered an opening 15 by 50 ft. and "apparently bottomless." A small spring of hot water, with "a strong smell and taste of sulphur," runs from this opening. The natural resources of Birmingham are evidently not yet exhausted.

THE MAKER OF THE CAST-STEEL GUN, Mr. HAINSWORTH, has had close tests made of the fragments of this unfortunate piece of ordnance. He now claims that he has discovered the fatal defects, and they are that the steel was too hard in the first place, and secondly, that his annealing furnace was too small to admit the whole piece, and the piece was as a consequence not properly annealed. He is still confident that he can make a gun of cast-steel that will stand the severest tests.

THE 15-IN. DYNAMITE GUN was tested again at Fort Hamilton last Saturday, and eight shots were fired. The projectiles were loaded with 175 lbs. of dynamite and explosive gelatine. One only failed to explode, and the average shooting was good as to range and aim. The projectile took from 11½ to 14 seconds to go one mile; and the first shot fell 1.6 yds. short of the "bull-eye," and the worst shot fell 86 yds. short. The average time of flight was 12 seconds and the average air-pressure in the gun was 1,000 lbs. per sq. in. The general result was pronounced very successful by the experts present.

THE "PHANTOM SHIP," the *W. L. White*, was abandoned in the blizzard of March 13, 1888, off Abesecom Light on the New Jersey coast. She was loaded with lumber and soon became water logged. Without crew or navigator, she struck the Gulf Stream and drifted in a generally northeasterly direction, and was quite often sighted in and near the path of ocean steamships. On Jan. 24 last she landed on the beach in the harbor of Stornaway in the Island of Lewis, one of the Hebrides. Thus in 11 months this crewless schooner traversed a calculated path of over 5,000 miles, and landed at a point actually 3,100 miles from the place where she was abandoned.

IMMIGRATION this year has been as follows:

			1888	1887	
12 mos. ending	Dec.	31	518,518	510,058	8,460 incr.
6 "	"	"	202,310	223,607	21,297 decr.
1 "	"	"	19,935	22,412	2,477 "

Immigration from England and Scotland during the past year decreased about 5,000; from Ireland about 1,000; from Germany about 5,000; and Sweden and Norway 5,000. Austria increased about 3,000, France 1,000, Italy 1,000 (47,442 in all of a most undesirable class of immigration) and other countries increased slightly enough to make up the aggregate. As a whole, immigration will be seen to be decreasing, but very slightly, and it is still far above the average of the past 15 years. The years 1881-4 are somewhat above 1888; all the other years, much below.

THE REFUSE DUMPING NUISANCE in New York harbor is to be done away with by making tows report for a certificate to a vessel anchored 7 miles out from Sandy Hook; at least, that is the plan recommended by Lieut. J. J. HUNKER, U. S. Supervisor of the port of New York. It would cost about $60,000 to construct a proper vessel. The supervisor reports that in 7 weeks 728,666 cu. yds. of refuse material passed the inspector at Fort Hamilton; and in addition to this, permits had been granted for the deposit of 320,000 cu. yds. of dredging for Long Island Sound and 1,200,000 cu. yds. for lower New York bay. The necessity for insuring the deposit of this material outside of the harbor limits is evident.

THE MORRIS CANAL is to be abandoned by its owner, the Lehigh Valley Railroad Co., after the present year, and it is doubtful whether any boats will be run upon it this year. The coal traffic on the canal has fallen to about 50,000 tons per year, which is not a sufficient traffic to pay the cost of maintenance. It is probable that the canal will find its future usefulness in connection with an improved water supply for the New Jersey suburbs of New York City.

THE PHILA. TRACTION CARS have caused the death of 21 persons in 3 years, says the Phila. *Press*. This is a low percentage of the total traffic; but the point that the *Press* wants investigated is why, with 5 accidents in 1886 and 4 in 1887, the rate jumps to 12 deaths in 1888. The overcrowding due to a scarcity of cars is the cause given. And it is a cause that is likely sooner or later to make serious trouble on the elevated lines of this city or of Brooklyn. More elevated or underground roads is the only feasible remedy here.

BROOKLYN UNDERGROUND WIRES aggregate about 3,000 miles in length, according to the 5th annual report of the Brooklyn Electrical Subway Board. Last year 1,495 miles of conductors were placed underground and 784 miles of wire removed from poles, and 317 poles were taken down. The Western Union Co. has already drawn 2,100 ft. of cable into the conduit on Atlantic Avenue. A practicable and safe system of subways for electric light wires has not yet been discovered by the Board.

THE ADAMS EXPRESS CO. has been given 30 days' notice of the termination of its contract with the U. S. Treasury Department for the transportation of public money and securities. The contract bears date Feb. 1, 1879, but the Government think the price paid is too high, and it will now invite proposals. The United States Express Co. is supposed to be the only possible rival.

THE PRICE OF ELECTRIC-MOTOR POWER, in Berlin, according to the *Berliner Electricitätswerke*, with the power supplied from central stations and the minimum consumption taken at 3,000 hours annually, is as follows:

1 horse power	$0.095 per hour
2 " "	0.180 "
3 " "	0.262 "
5 " "	0.425 "
8 " "	0.660 "
12 " "	0.995 "

THE PARIS SEA-PORT project is making progress. A French company offers to execute the work at its own cost, provided it is granted a toll of 60 cts. per ton on all vessels entering the canal above Rouen. It is proposed to dig a canal 20 ft. deep, along the Seine from the latter place to Paris, a distance of 112 miles. The present average depth of the navigable channel of the Seine is 8.2 ft.

THE SUNKEN *Atlas*, which lies in the North River opposite the entrance to the Barclay Street ferry, is to be removed—sometime. The authorities in charge have listened to complaints in reference to the matter, and the owners of the steamer have explained that the contract for raising her has been let to the Merritt Wrecking Co., who can raise the boat if any firm can.

The facts of the case, so far as the public can see, are that the wrecking company began work very promptly in the first instance, and had the work of raising the vessel well under way. A few days of cold weather caused ice enough to form to give them some trouble, and after having progressed far enough to move the vessel three or four hundred feet up-stream they abandoned the job and stated that they would let the vessel lie there till next summer before resuming operations.

Such action as this with regard to such a dangerous obstruction to navigation lacks little of being criminal, and the owners of the vessel, who permitted it, have little claim to consideration when the public authorities decide upon future action.

THE GREENSBURG, KANSAS, WATER-WORKS, as reported in the daily press, takes its supply from a well 102 ft. deep and 30 ft. in diameter. This well is sunk through sand and clay to a depth sufficient to be out of reach of the alkali strata, and is walled with stone laid in cement. A tank resting on a timber trestle work over the well, forms a water-tower, with the surface of water in the tank about 112 ft. above the street level. The tank holds 78,000 galls. and is filled by a steam pump of 80 H. P., with another pump of like capacity in reserve. The village has 1,500 inhabitants, and the daily consumption is about 16,000 galls. The whole plant, including distribution system, cost $47,000, and the annual operating expenses are put down at $2,400.

THE U. S. PATENTS issued in 1888 amounted to 20,420, of which number 1,536 were to citizens of foreign countries. There were 86 reissues, and 1,059 trade-marks and 21,892 labels registered. The total receipts of the department were $1,118,516, and the total expenditures were $974,516. On Jan. 1, 1889, the Patent fund in the U. S. Treasury amounted to $3,401,898.

THE MOST SERIOUS STRIKE which has occurred in New York City since 1886 was started this week by the employés of the street-car companies of the city. All but one of the north and south roads and three of the cross-town lines have been tied up; and acts of the strikers and their sympathizers, and their resistance to large bodies of police, have fallen little short of rioting. Were it not for the elevated railways, business in New York would be almost entirely blocked; but though there is much discomfort and no little danger from the overcrowding of the elevated lines, favorable weather has thus far enabled them to handle the enormous traffic successfully. On one day this week, the New York elevated roads carried 619,000 passengers, the gross receipts from whom were $30,950. The crowding, delay, and partial suffocation which most of these passengers had to undergo were doubtless more effective arguments to persuade them of the need for better transit facilities in this city than could have been made in language, with the most eloquent rhetoric or the most convincing logic.

Street Railroads in Europe.

Mr. VON LINDHEIM, an Austrian engineer, has compiled the statistics of street railroads in Europe. The development of such roads dates back not more than 15 or 20 years. In England, France, Germany, Belgium, Holland, Austria, and Switzerland there are 221 cities having street railroads. Among these, 118 are in England, 43 in Germany, and 23 in France, there being no city of less than 20,000 inhabitants having such roads, while in the United States they are found in cities of not more than 1,000 inhabitants. In Europe there existed in 1886-87, 4,330 miles of street railroads, while the United States had 5,932 miles. England had 883 miles on which 416,518,423 passengers were carried. In Germany 245,657,503 passengers were carried on 523 miles of road. In England 472,356 passengers were carried over each mile; in Germany, 468,874; in France, 545,815. There were 3,345 street cars in Germany, 3,494 in England, and 2,780 in France, against 22,940 in the United States. In the latter, 92,203 horses, 12,217 mules, and 248 locomotives were in use on street roads. Of considerable interest is the comparison of distance traveled each day by the horses. In Berlin, a horse gives an average of 16.1 miles; in Posen, even as much as 16.7 miles; in Vienna, 14.5 miles; in Paris, 9.9 miles; and in Hamburg, 13.7 miles. The use of mechanical motors in place of horses is steadily increasing. It is particularly desirable in those places where the daily variations of traffic are considerable. In Berlin, for instance, the Sunday and holiday traffic is 27 per cent. of the whole, and in Vienna even amounts to 34 per cent., while on Wednesday the street cars are very little used. Mr. VON LINDHEIM is a strong advocate of the use of electric traction in street railroads, and states that in Europe the cost of horse-traction is 1.47 if that of electric traction is assumed as 1.—*Science.*

EMMENSITE.—The new explosive, emmensite, which is now attracting considerable attention, is prepared, according to *Engineering*, by dissolving at a moderate temperature an excess of picric acid in nitric acid of a density of from 50° to 60° Beaume; an operation which can be performed without danger if the temperature is kept low. On evaporating the liquid afterwards, fine rhombic crystals of a bright yellow color are first deposited, which are followed by others of a lighter hue, and finally by a precipitate of a light grey color, the whole of these three being probably isomers, though their composition has not as yet been determined with accuracy. It has, however, been recognised that they contain more hydrogen than picric acid, and a quantity of oxygen insufficient for complete combustion.

To provide this missing quantity, Dr. EMMENS, the inventor of the explosive, employs ammonium nitrate, the mixture being effected by melting together five parts by weight of the above crystals with five parts of ammonium nitrate over a paraffine bath; when completely fused, six parts of picric acid are added and thoroughly incorporated, after which the whole is poured out into suitable moulds. These operations involve no danger if the temperature is kept below 200° Cent. Thus prepared, emmensite is an amorphous solid of a bright yellow color, completely odorless, but having a bitter taste. It has a spongy texture, and its specific gravity is 1.7. Microscopic examination tends to confirm the opinion that it is a chemical compound, and not a mere mixture. The explosive is made in several degrees of strength, some of the qualities resembling dynamite, whilst others can be used for firearms. It is but slightly sensitive to shock, and No. 1 emmensite can be heated without exploding, but Nos. 3 and 4 detonate slightly when raised to a high temperature.

Oil *vs.* Coal for Burning Brick.

The use of fuel oil for burning brick is not exactly a new utilization of this material, but it is sufficiently new to be yet in the testing stage, and any information from those practically handling the various fuels used for this purpose must be useful. At the late Memphis meeting of the National Association of Brickmakers, as reported in the *Clay Worker*, we find a paper on this subject by Mr. S. P. CRAFTS, followed by an interesting discussion, and from both we make the following abstracts:

After some introductory remarks, Mr. CRAFTS said:

As it would be a long and difficult task to give the values of different fuels in all localities, I will take the cost in southern New England. One cord of beech wood, worth $4.00, contains 17,065,000 heat units; one ton of bituminous coal at $4.00 contains 31,227,000 heat units; four barrels of fuel oil, 40 galls. each at $1.00 per barrel, at 6 lbs. to the gallon, gives us 20,160,000 heat units.

Here, then, we have data based on the cost and heat values for one locality, the variation from which will not be large from any of the brick manufacturing centers in that region, in which I include the Hudson River, New Jersey, etc.

Now, which shall we use? I do not consider gas in this paper, for I do not know anything about it, and it is not practicable for most of us. The greatest cost for labor in burning, and the least cost for fitting up, is the wood, but it involves the greatest cost for fuel. The greatest cost for fitting up, and a smaller cost for labor in burning, is with coal, but with the least cost for fuel if you could utilize all the heat it contains. With oil, the cost of fitting up is more than with wood, but less than with coal unless you build permanent wall, and even then it is somewhat less and the labor in burning is least of all. But the cost of burning with oil is less than with wood, but more than with coal, unless you can utilize a much greater per cent. of the heat of the oil than that of coal. Now, it is claimed that you can get all the heat there is in the oil, at least 19,000 out of the 20,200 units, and that with coal you get but 8,000 or 8,500 out of the 14,300 units. You must remember, however, that these are claimed as proportions in the pound weights of the two fuels. When we consider the cost, they more nearly approach each other; 12 lbs. of oil costs 5 cts. and 12 lbs. of coal costs 2 1-7 cts., therefore to get at the relative values we must estimate the work of 12 lbs. of oil and the work of 28 lbs. of coal; 12 lbs. of oil at 19,000 heat units gives 228,000 heat units as against 224,000 at 8,000, or 238,000 at 8,500.

From this it seems that there is very little difference between the cost of coal or oil unless some other consideration intervenes. But there is a consideration of the lesser expense of fitting up for oil, the saving of time in burning, the fewer hands required, and the ease with which you can increase the heat. You may keep your bricks at a dull red for any length of time and fail to burn them hard; but if you can in a shorter time with oil get the requisite temperature, then you do the work in less time and at a saving of fuel for the radiation of the heat of a kiln in six or seven days is no small item. It seems to me that in this shortening of time and saving thereby is the principal argument in favor of oil over coal, but it becomes us to consider whether the difference of the percentage of heat utilized under a boiler when burning oil or coal will hold good when diffused in and through a kiln of brick. I do not think it will, for a kiln seems to take up all the heat of combustion in either case, certainly until the last stage of burning, when the blanket of steam ceases to hold down the heat as in the earlier stages,—a condition very different from the smoke-stack of the boiler.

In summing up I should say that wood is the simplest and most expensive in most localities, certainly in localities where the greatest number of bricks are made, but that between coal and fuel oil it is an open question yet to be determined by a longer and more thorough test.

For myself, I have used coal over 4 years at a cost of about 50 cts. per 1,000, and am now trying oil in the latter stage in burning to get a larger volume of heat and to deepen the color of brick when burned. We have just finished burning a kiln of 19 arches, containing 451,000 brick, using 67 tons of coal at $4.25 per ton, making the cost per 1,000 63 6-40 cts. This kiln of 451,000 brick contains 15 ton of coal-dust as against 18 tons in the same number of brick made last year. This amount and the height (six bricks higher than last year) may account for the longer time and greater relative consumption of coal than usual; two hands to do the work. We set 52 bricks high to economize the shed room, but are satisfied that 46 high is better and more economical.

The reasons given above for the higher cost of burning do not hold good, for we have since burned a kiln of 474,000, made in precisely the same way and set the same height, at a cost of 50 cts. per 1,000. Cause, better coal.

Mr. D. V. PURINGTON in discussing this paper said:

I have burnt this year a little over 28,000,000 bricks without using a stick of wood or a pound of coal—entirely with oil. Of course my brick are artificially dried. We have taken out of each brick from the time it was made till it was set in the kiln, a pound and a quarter of water, so they are about as dry as can be got, practically. We start one side of the kiln three or four hours before we do the other, and we get the heat up just as fast as we can get the draft started. When we first start, of course without the arches being heated at the sides to aid the combustion, we have to burn more oil. Our fire is oil, and we burn on an average four days, where the average was about seven days and a half before. I burn in kilns of 24 arches each, and where we used five men before, we now use two. We have no ashes to haul away, no coal to unload. We unload all our fuel with a little steam pump, and it is then ready to be drawn by gravity from the tank to the kiln. I can state unequivocally that I know of no inducement other than a pecuniary one that would lead me to go back to burning common brick, artificially dried, with wood or coal. I'm not up on heat units and shall endeavor to talk in a language that brickmakers can all understand. I don't know a unit of heat; wouldn't know a dozen if I should see them right here. The cost for fuel has been, for oil, an average of 30½ cts. per 1,000. In the beginning, before we understood oil and its uses, we used a great deal more, and we are all the time improving upon it. Any science so new as the burning of brick with crude oil is susceptible of great changes, and I expect it to improve for the next ten years. The exact total cost of burning brick so far with me I have been unable to ascertain, for this reason—I take my steam from a stack of three boilers, and the same steam from the three boilers is used for running my machines in the day-time, and also for my kilns, and for burning brick, so I have been unable to divide the amount of steam I use for burning brick, and the only way I can get at it is relatively, and my figures show the total cost for labor fuel, oil and coal for burning brick this year has been 52 1-3 cts. as compared last year with 22 cts. using wood and coal.

STEEL WATER PIPES are gaining ground, and a Scotch company is now making 20 miles of such water pipe for use in Mexico. The diameter is not given, but the thickness of the steel plate is 1-10-in., and the engineers say that previous experience shows them that corrosion need not be feared. The Sydney water-works have lately issued tenders for 1,600 tons of steel water mains of a large size.

The Worthington Pumping Engine in England.

The accompanying cut from *Engineering* of a high-duty Worthington pumping engine will be interesting to American engineers as showing how differently the same machine may be treated in its constructive details. Our readers must judge for themselves whether or not these details, as here shown, are an improvement upon the compact and carefully studied type of the engine with which so many of them are familiar. Individually we have a decided preference for the American pattern.

But while the English engineers differ in their interpretation of the Worthington design, they have preserved the essential features, as far as results are concerned, as is shown in the appended report of Mr. E. A. COWPER, one of the best known and most reliable of the English experts. This report is here given in full as an example of what may be called the best English practice, as follows:

6 Great College-Street,
WESTMINSTER, S. W., Dec. 7, 1888.

Messrs. J. Simpson & Co., Limited,
Worthington High-Duty Pumping Engine.

Dear Sirs,—I beg to report that, in accordance with your request, I have made a careful trial of the Worthington pumping engine erected at the works of the New River Company, Green Lanes, Stoke Newington, and I have to thank Mr. E. L. MORRIS, A. M. I. C. E., engineer to the company, for the care he took to insure the trial being as complete as possible.

I arranged for the trial to last 24 hours, viz., from the morning of November 23 till the morning of November 24. I purposely had the engine and boilers at work for some time, in an entirely normal condition, before commencing the trial; the state of the fires being particularly noticed both before starting and at the end of the trial, and measured as closely as possible by inserting a bridge edgewise on the bars.

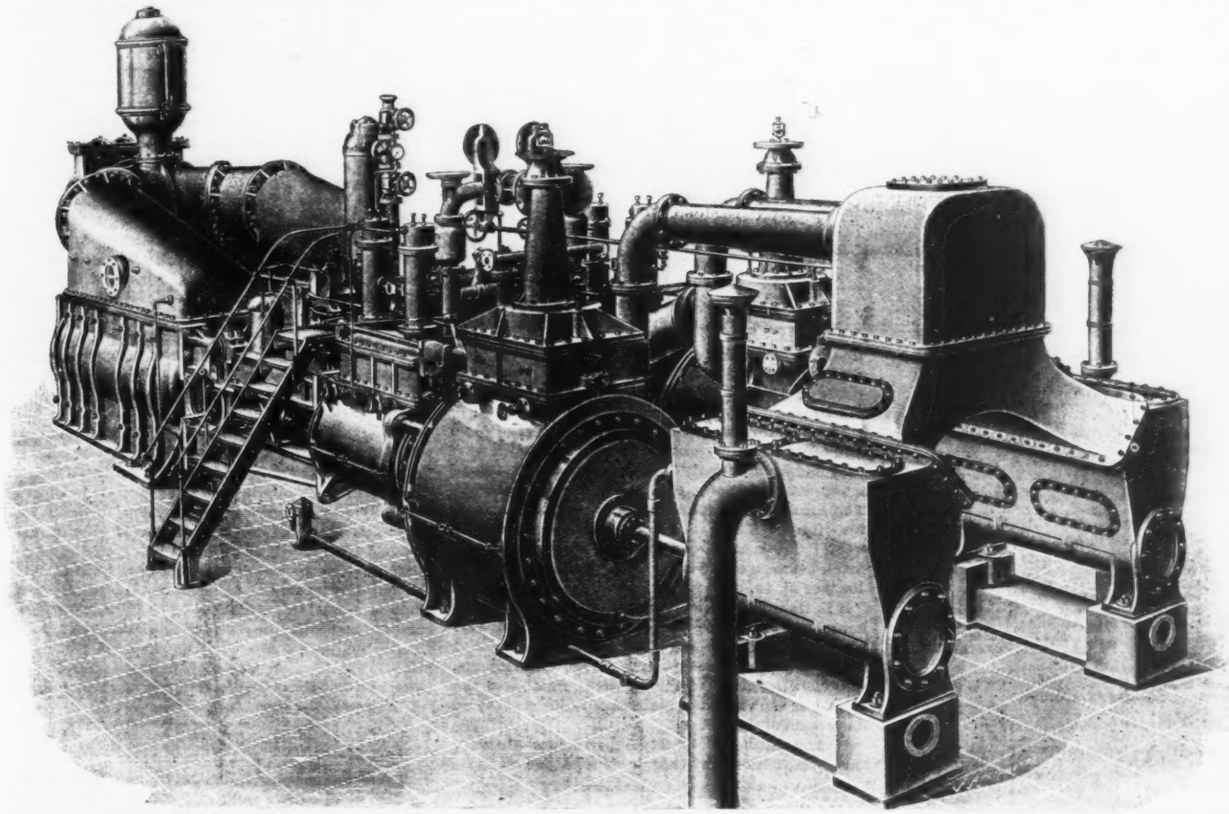
A tank holding an exact weight of water was provided, in which the weight of water delivered to the boilers was exactly taken, its temperature being also noted.

The coal, which was "Nixon's Navigation," was carefully weighed in scales in the stockhole, as required by the boilers.

Indicator figures were taken from each end of each of the four cylinders of the engine throughout the trial. The temperature of the hot well and injection water was taken frequently, as well as the steam pressure, vacuum, and air pressure in the compensating cylinders. The strokes of the engine were registered by a counter, and the head of water in the main and suction was continually noted, and generally every precaution was taken to insure an accurate result as to the working, economy, and efficiency of the engine and pumps.

In my opinion, the trial was under one disadvantage, viz., that three boilers only were used in place of four, resulting in the heating surface being smaller than one would have wished, in order to obtain the greatest economy. The boilers were Lancashire or two-flued, and had no Galloway tubes in them.

The engine is of the Worthington horizontal type, there being a steam-jacketed high and low pressure



Worthington High-Duty Pumping Engine at West Middlesex Water-Works; Constructed by J. Simpson & Co., Engineers, London.

cylinder with one piston-rod on each side of the engine, the piston-rod on one side working the steam valves of the other side, so that the motions of the piston-rods follow after one another, and are not simultaneous, except just as one finishes its stroke and the other begins; hence the flow of water in the main is almost exactly uniform and continuous.

The pressure of steam being 80 lbs. and the expansion being about twelve times, it was highly satisfactory to observe how completely the Worthington "compensating cylinders" took up the excess of power during the first half of the stroke, and gave it out again during the second half, thus completely avoiding the necessity for a crank and fly-wheel, the velocity of the piston being very uniform throughout the stroke, and starting and stopping so quietly and easily that there was no blow of any kind; in fact, it was almost impossible to tell from the pumps whether they were at work or not. The pump plungers of the pumps, which are double-acting, are attached to the front ends of the piston-rods and the air-pumps to the back ends of the rods. The "compensating cylinders" are vibrating cylinders, and are centered above and below the piston-rods, and their pistons are attached to the cross-heads of the piston-rods, so that the "compensating cylinders" are vertical at half-stroke and inclined at either end of the stroke. A pressure of 158 lbs. of air is kept up in a small air-vessel by a small air-pump, the air pressing upon water that passes in and out of the "compensating cylinders" and acts on their pistons with a continuous pressure.

The whole of the power of the steam first cut off and expanded in the high-pressure cylinder and then passed into a steam-jacketed reservoir, and from that into the low-pressure cylinder where it is cut off and expanded much more, is developed upon the one rod, which

once takes hold of the pump plunger, and thus the motion is perfectly direct, without the intervention of any parallel motion, beam, connecting-rod, crank, shaft, or fly-wheel, and consequently the friction of the engine and pump is very small, so that about 91.5 per cent. of the power of the steam is utilized, with the result that 112 lbs. of coal does about 109,000,000 foot-pounds duty, or say 2,034 lbs. of coal per water horse-power, assuming the pumps to fill, which they have every chance of doing.

Results of Trials of Pumping Engines Constructed by Messrs. JAMES SIMPSON & CO.

	Lambeth Water Works Ditton.	West Middlesex Water-Works, Hampton.		New River Water-Works Stoke Newington.	West Middlesex Water-Works, Hammersmith.	
Type of engine	Receiver b'am	Worthington		Worthington	Woolf beam	
Engineer who conducted the trial	Mr. E. A. Cowper, M. I.C.E.	Prof. Unwin, F. R. S.		Mr. E. A. Cowper, M.I.C.E.	Mr. Thos. Hack, M.I.C.E.	
Head on pump in feet	35.0	53.7	60.6	148.5	187.7	187.2
Efficiency per cent	77.4	84.9	84.3	91.5	85.8	85.0
Feed water per actual water horse-power, jackets being on circulation, pounds per hour.	18.4	17.6	17.9	16.13	17.3	17.3
Quality of coal used	Nixon's Navigation Welsh coal used in all the trials.					
Percentage of ash and clinker in coal	3.3	3.9	3.9	1.8	0.95	1.7
Pounds of water evaporated per pound of coal (ash and clinker included) on trial from the feed temperature	8.347	9.914	9.914	7.74	9.44	9.37
	The jackets being in circulation	Including jackets		The jackets being in circulation.	The jackets being in circulation.	
Duty in pounds of water raised 1 ft. high per 112 lbs. of coal, including ash and clinker which are not deducted, and assuming the same evaporation as was found by Prof. Unwin, the full pump displacement being taken in all cases	112,626,200	111,500,000	111,500,000	121,032,000	118,094,000	117,650,000

DIMENSIONS, ETC.

Engine.

High-pressure cylinders	27 ins dia.
Low " "	54 "
Stroke	3.603 ft.

Pumps.

Diameter of main pumps	28 ins.
Stroke	3.603 ft.

Boilers.

Three double-flued boilers, each	7 ft. by 26 ft. dia
Two flues	2 ft. 9 in. dia.
Grates in each boiler equal	27½ sq. ft.

Observations.

Steam pressure on trial, average	79.8 lbs.
Head of water on pumps "	148.48 ft.
Temperature injection	46°
" air-pump discharge	76.2°
" feed-pump delivery	49.6°
Average total strokes per minute	35,312
Vacuum	28 ins.
Barometer	30.2 ins.

Results.

Total indicated horse-power	330 h. p.
Pump horse-power, calculated from full displacement	301.92 h. p.
Mechanical efficiency, per cent.	91.5
Friction	8.5
Coal used per indicated horse-power per hour including the ashes	1.905 lbs.
Allowing for difference of temperature between cold feed and hot well, viz., 26.5°	1.86 "
Coal used per pump horse-power (as above) including the ashes	2.082 "
With the same deduction for temperature as above	2.034 "
Water evaporated per pound of coal, excluding that condensed in jackets which was in circulation and not measured	7.74 "
Water as steam used in cylinders per indicated horse-power per hour (including that condensed in jackets	14.75 "
Water as steam used in cylinders per pump horse-power (as above)	16.13 "
Duty 11½ lbs. of coal, including ashes	106,500,000 ft.-lbs.
Duty, allowing for difference of temperature of feed water (as above)	109,000,000 "

I am yours truly,
(Signed) E. A. COWPER

Laws of Crushing Strength of Brick.

By PROF. IRA O. BAKER.

There is great diversity in the results obtained by different observers for the strength of brick. These differences are so great that it seems unreasonable to believe that they are due entirely to difference in the strength of the bricks themselves. The writer will briefly describe a series of experiments made to determine the effect upon the apparent strength of a variation in the size of the piece tested. The first step was to determine the relative strength of a quarter, a half, three quarters, and a whole brick; and the second to ascertain the strength when tested flatwise, edgewise and endwise.

1. The experiments were made upon a dry clay (pressed) face brick remarkable for its regularity of form, homogeneity of structure, and uniformity of burning. The brick were selected by size and color, and then broken in a machine approximately to the required sizes. If the broken face was not reasonably near a plane perpendicular to the other faces, it was clipped until it was. No attempt was made to bring the specimens to mathematical forms, although none departed very much therefrom. In preparing the specimens great care was taken to so combine the pieces of the several bricks that any peculiarity of any one brick would be as nearly eliminated as possible, and the identity of each piece was preserved, so that the effect of any brick upon the final result could be traced. The specimens were crushed between parallel (self-adjusting) cast-iron pressing surface in a RIEHLE hydrostatic testing machine.

The surfaces were as manufactured, being plain and quite smooth—probably nearly as smooth as if they had been rubbed. The pieces were tested on what was originally the broad side of the brick. The bricks were 2⅝ ins. wide, 8⅝ ins. long and 4½ ins. thick. They should probably be classed as "soft" brick, since the crushing strength of half brick between cast-iron pressing surfaces was 3,573 lbs. per sq. in.

It is thought not worth while to give the record here; but it may be stated that the results were plotted and a line drawn which was thought to most nearly represent the average of the experiments, weight being given to the apparent quality of the bricks, as shown by the manner of failure and by an inspection of the pieces.

2. The results of twenty experiments are very closely represented by the simple relation:

Strength of whole brick = 100 per cent. = 6
" " ¾ " = 83 " = 5
" " ½ " = 66 " = 4
" " ¼ " = 50 " = 3

The above results and ten others on cubes of brick can be represented by the formula

Strength in pounds per sq. in. $= 2500 + 50(A - 4)$,

in which A is the bed area of the specimen, in square inches.

No attempt was made to harmonize the two laws, each being deduced independently of the other, and the nearest round numbers being taken in the second case.

It is not claimed that these laws will hold good on a brick, either harder or softer than those used; but until experiments show the contrary, they may be assumed to be correct, at least approximately, for any homogeneous brick or stone of the above dimensions and conditions of surface. The brick tested at the Watertown Arsenal on the United States testing machine give much larger results than are obtained elsewhere. The method of testing employed there is to apply the pressure to the broad side of a whole brick; and hence the above is a reason why the apparent strength is so great, and also gives data for eliminating one point of difference between the Watertown and other experiments.

3. In the same general way, and with the same quality of brick as above, the writer determined that the strength for the three positions is as follows:

Whole brick flatwise = 100 per cent.
" " edgewise = 80 " "
" " endwise = 50 " "

Experiments on bricks of other quality (all harder) with plastered beds, gave results essentially the same as above, except that the strength edgewise was more nearly 75 per cent. Hence in round numbers it may be said that the crushing strength of brick in the three positions—endwise, sidewise and flatwise—is about as 2, 3 and 4 respectively.

Most of the experiments of which the writer has been able to find records bear out these conclusions reasonably well. Experiments reported in Trans. Am. Soc. of Civ. Engrs., Vol. 7, page 283—the same being tests of brick used in the construction of the Brooklyn bridge—constitute an apparent exception. As these experiments are frequently referred to and have found their way into the text books and manuals, it is well to consider them a moment. The observed crushing strength for the three positions is reported as follows:

Half brick flatwise = 3,371 lbs. per sq. in.
" " sidewise = 4,612 " " "
Whole brick endwise = 2,065 lbs. per sq. in.

It is well known that some brick machines mould the clay in layers, and that the laminæ may be parallel to any face, depending upon style of machine used. As yet the writer has been unable to learn anything definitely about the manner of manufacturing these bricks; but he has private information which makes it probable that these bricks were machine moulded, and that the abnormal results were due to the direction of the lamination.

4. The writer also found that for ordinary hard brick, which were quite regular in form, there was a difference of about one-half when tested between parallel cast-iron pressing surfaces, between the strength of specimens having plastered beds and those not plastered. He also found that surfaces ground perfectly flat gave about 10 per cent. greater strength than those having plastered beds. Since the Watertown results were obtained from specimens whose pressed surfaces were ground perfectly flat, this is another reason why those results are so high.

All of the above shows how indefinite it is to say that the crushing strength of brick and stone is so much per square inch, and not give full details as to the manner of obtaining such results. In conclusion, it may be well to state that the crushing strength of individual brick is useful only in comparing the quality of different brick, and gives no indication of the strength of masonry built of such brick. For example, masonry composed of brick having a crushing strength of 15,000 lbs. per sq. in., and of mortar having a crushing strength of 128 lbs. per sq. in., has a strength of only 1,508 lbs. per sq. in. Hence, the form of test specimen is a matter of no moment, but the size of specimen and the condition of the pressed surfaces are very important.

Railways in Ceylon.

There are now 182½ miles of railway in operation in Ceylon, all single track and of 5 ft. 6 ins. gauge. The first line was opened in 1867. All the roads are owned and worked by the Government, and were built with capital borrowed in England. The cost of the up-country lines was $99,206 per mile, including track, workshops, rolling stock, stations, etc. The width at sub grade is 20 ft., and 18 ft. in cuttings. The rails weigh 72 lbs. per yard and are fastened to ties 10 ins. × 5 ins. × 9 ft. 9 ins.; these are spaced 3 ft. apart, except on steep grades, where two ties are added in each rail length; most of the ties are of Norway pine, creosoted, and they are completely buried in the ballast to protect them from the sun and rain. The lines have steep grades and many sharp curves. There are grades of 1 in 44 and 1 in 45, and the sharpest curves are 330 ft. radius. On the coast line, which is practically level, the speed is about 15 miles per hour, including stops. About 123 miles of the system are now the unincumbered property of the colony, but some lines are profitless owing to the immense cost of construction and the comparatively light traffic. Several lines on the 5 ft. 6 ins. and 1 metre gauge are projected. The total cost of the present roads has been $16,166,132, exclusive of interest, and there is a debt, owed abroad, of £6,266,000 at 4 per cent. The mistake has been in the building of such expensive broad-gauge roads.

THE MEXICAN TELEGRAPH CO. is reported to have completed arrangements for laying a new cable in the Gulf for South American business. The new line will be about 1,000 miles long, running from Galveston to Coatzacoalcos, 200 miles below Vera Cruz. The steamer *Faraday* is laying the new cable, which weighs about 3 tons to the mile, and the work will be completed in February.

The Hardie Sewage Plant.

The system here illustrated and described from a late number of *Industries* is the patented invention of Mr. W. YOUNG HARDIE, of Withington, near Manchester, England. Figs. 1 and 2 show a plan and a sectional elevation of the system of reservoirs

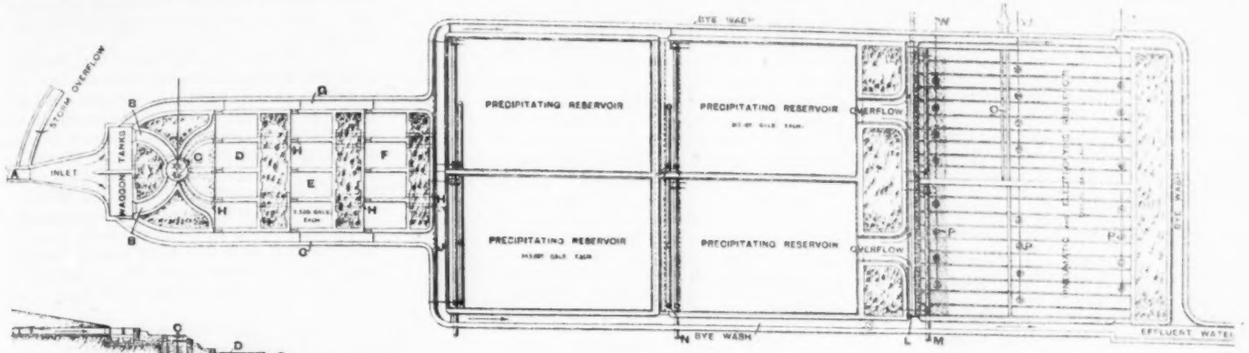


FIG. 1.

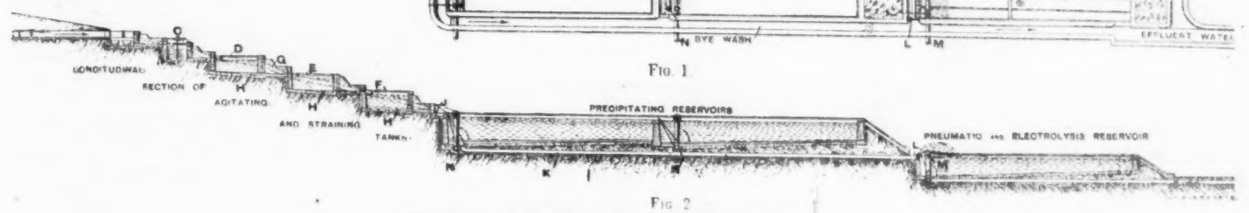

LONGITUDINAL SECTION OF AGITATING AND STRAINING TANKS.
PRECIPITATING RESERVOIRS
PNEUMATIC AND ELECTROLYSIS RESERVOIR

FIG. 2.

Hardie Sewage Plant; Precipitating Reservoirs.

through which the sewage is passed, and in which it is treated. Figs. 3 to 8 show various views and sections of the furnace for cremating the town refuse, and the solid matter deposited in the precipitating reservoirs. The sewage in the first instance is discharged from the main sewer at a point marked *A* in Figs. 1 and 2, and flows into the perforated wagon tank—except in the case of a storm, when it is turned into the storm overflow. From thence it is conducted, by means of the overflow surface feeders *B*, into the agitating tanks *C*, where it is mixed with deodorizing powder, for the purpose of precipitation.

The sewage then passes into a series of straining tanks *D E F*, where it is strained through wire meshes, which become finer in each series. It should be stated that there is a channel *G* on each side of the tanks, fitted with sluices, which are intended to collect any by-wash from the wagon tanks, and conduct it into the straining or precipitating tanks. The sewage is passed from one straining tank to another, by means of conduits below the strainers *H*—one of which conducts the effluent into the feeder *I*, over which it passes into the precipitating or filtrating tanks. The filtering material in the tanks consists of a bed of screened refuse cinders placed upon perforated tiles. The effluent thus obtained is drained into a pipe *K*, through which it is conducted to the feeder *L*, and over a perforated air or oxygen gas pipe *M*, which throws the fluid, in the form of spray, into the electrolysis reservoirs, thereby revivifying the liquid. The solid matter deposited in the precipitating tanks is discharged, by means of the sludge pipe *N*, into consolidating tanks. The effluent in the electrolysis reservoirs is further revivified and deodorized by means of air from a perforated pipe *O*. The electrodes *P* are connected, by suitable cables *W*, to dynamos, from which currents of electricity are passed through the liquid, to agitate and precipitate any coloring matter which may be held in suspension. The effluent, which should now be crystalline in appearance, is finally discharged in an inodorous and innocuous condition, by means of a channel, into any convenient stream or river.

The furnace for cremating the town refuse and sewage solids, which is shown in Figs. 3 to 8, is of a special character, and made to combine cheapness and durability with efficiency. Some of the advantages claimed by the inventor are: The use of town's refuse as fuel, which assists to destroy, if it does not completely destroy, any sewage deposits, and at the same time generates high pressure steam in a boiler without extraneous fuel; the drying of the sewage sludge in retorts or chambers before burning; the purification of the vapors created in the desiccating process, by passing them through a blower and furnace fire; the propulsion of the fumes through the condenser and up the chimney; and the elimination from the refuse of a deodorizing and precipitating powder for purifying the sewage and precipitating its solids. The furnace is chiefly constructed of iron plates, with a fire-brick lining, while a special round boiler is situated on the top above a large fire-grate area, under which wagons

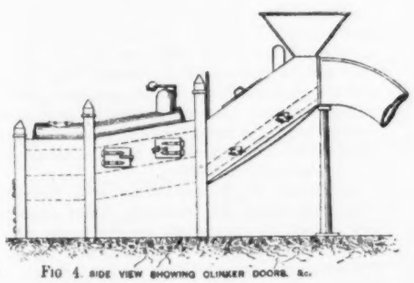


FIG. 4. SIDE VIEW SHOWING CLINKER DOORS, &c.

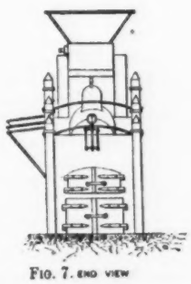


FIG. 7. END VIEW

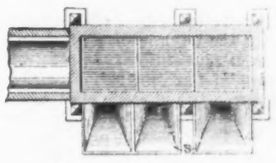


FIG. 6. PLAN OF FIRE GRATE

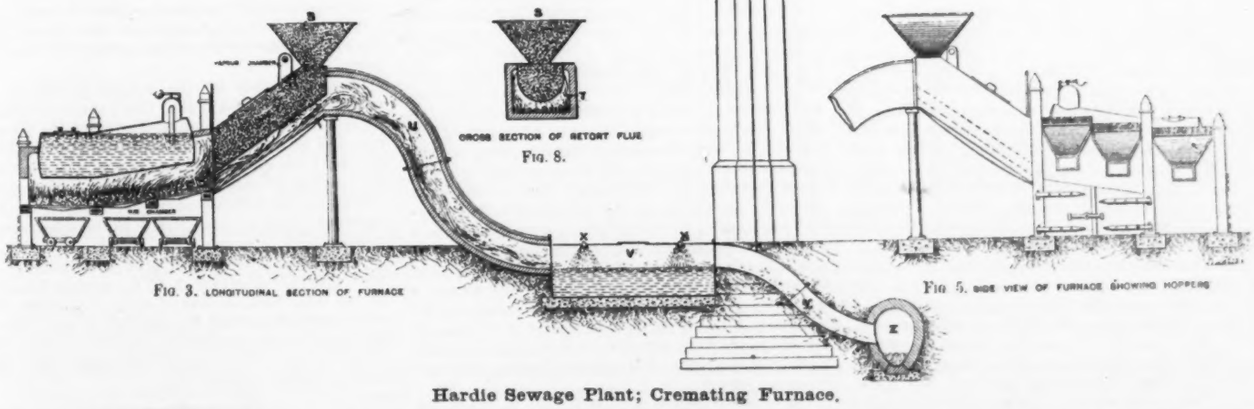


FIG. 3. LONGITUDINAL SECTION OF FURNACE.

FIG. 8.

FIG. 5. SIDE VIEW OF FURNACE SHOWING HOPPERS

Hardie Sewage Plant; Cremating Furnace.

can be run to catch the falling ashes. This space also acts as a blast chamber. The action of the furnace is very simple, the refuse being tipped into the hoppers *S*, as shown in Fig. 8, from whence it is automatically delivered on to the fire partially dried, and during the process of cremation assists in generating steam in the boiler. The fumes evolved during combustion pass up the flue *T*, thereby drying the refuse within the retort, then along the main flue *U*, and into the condenser *V*, where they are purified by means of water sprays *X*, previous to entering the coke or water scrubbers, by which they are thoroughly cleansed prior to escaping up the chimney or into the main sewer *Z*. The inventor proposes to make use of sanitary tubes in the construction of the scrubber casings, which are partially filled with coke or fitted with shelves and a water spray in the usual manner.

The World's Copper Production.

The total output of copper, according to very complete records in the *Engineering and Mining Journal*, has been in long tons:

	United States	Other North America	South America	Europe	Asia	Africa	Australia	Total	Price per lb. cts.
1879	23,000	1,950	53,815	53,866	3,900	4,828	9,500	150,859	17⅛
1880	27,000	1,950	47,616	59,370	3,900	5,239	9,700	154,775	20⅛
1881	32,000	2,551	44,389	65,006	3,900	4,067	10,000	161,913	18⅜
1882	40,467	2,401	51,108	66,787	4,800	6,516	6,512	180,390	18⅛
1883	51,574	2,597	47,485	72,172	7,800	6,575	12,271	300,274	15⅞
1884	63,555	1,196	48,269	75,224	10,000	5,200	14,100	216,338	13⅛
1885	74,053	3,653	44,573	76,245	10,000	5,700	11,400	224,218	11⅜
1886	69,971	3,415	40,098	75,234	10,000	6,125	9,700	214,533	11
1887	78,571	4,630	33,570	81,086	11,000	7,400	7,700	223,957	11¼
1888	105,357							255,357	10¾

Exports of United States copper and copper ore have very rapidly increased since 1881 from a value of $876,395 to a value of $11,402,021 in 1888. United States lead production has increased quite uniformly from 42,540 tons in 1873 to 189,000 tons in 1888.

The Vancouver Water-Works, and Pipe-Laying across Burrard Inlet.

The question of a water supply for Vancouver, B. C., was first considered by Mr. GEORGE A. KEEFER, M. I. C. E., in June, 1885, some months previous to the incorporation of the city of Vancouver. A careful study of the physical conditions convinced him that a supply of water could only be advantageously and economically obtained from the north side of Burrard Inlet, or that opposite to the city. On Dec. 2, 1885, he put a party in the field at his own expense, headed by Mr. H. B. SMITH, C. E., and surveyed both shores, and sounded the inlet for the best pipe-crossing. He selected Capilano river as the best source of a gravity supply. With the data thus obtained Mr. KEEFER interested several prominent capitalists in his project, and in April, 1886, a charter was obtained from the Legislature of British Columbia authorizing the construction of the works.

The fire of June, 1886, which entirely destroyed the young city, delayed matters somewhat; but in June, 1887, a final location was made, and Aug. 23 the first contract was let. The Capilano river is a mountain stream about 50 miles long, falling from 70 to 100 ft. per mile. At 6¼ miles above its mouth, a stone-filled crib dam was built, and finished in April, 1888, under extremely difficult circumstances, by Messrs. H. F. KEEFER and D. MCGILLIVRAY. This dam is 385 ft. long, 41 ft. wide and 12½ ft. high. The clear tumbling way is 165 ft. long, supplemented by a sluice-way 14 ft. wide. It cost over $75,000. The reservoir thus formed is 380 ft. by 700 ft. and holds about 14,000,000 galls. The crest of the dam is 417½ ft. above the lowest and 200 ft. above the highest point in the city limits.

A 22-in. main leads from the dam 2¼ miles down stream, where the water enters a tunnel 280 ft. long and 6×4 ft. From the tunnel a 16-in. main passes to Burrard Inlet, a distance of 4 miles. This inlet is 1,086 ft. wide at extreme low water, 1,237 ft. wide at ordinary water, and 2,800 ft. wide at extreme high water. The north shore is flat for some distance back, but the south rises abruptly about 12 ft. The greatest depth of water is 58 ft. at low tide, and 70½ ft. at high tide, with a uniform bottom curve. The tidal currents range from 4 to miles per hour, being sufficiently strong to break a 9-in. manila hawser floating on the surface and fast on either bank. At the inlet the 16-in. main was reduced to 12 in., but in the future three additional 8 in. pipes will be laid across in parallel rows 50 ft. apart, fitted with independent stop-cocks. On the south side a 16-in. main is again laid, a distance of 1 mile to Coal Harbor, and the beginning of the city.

The 22-in. and 16-in. pipes are made of mild steel plates, riveted in 23 ft. lengths; the 22-in. pipe weighs 736 lbs. per length, and the 16-in. 552 lbs. The plates are 11-100 in. thick, and have a warranted tensile strength of 72,000 lbs. per sq. in. The joints are of the Smith & Moore pattern—that is, a band of steel 6 ins. wide and ¼ in. thick encircles the junction of two lengths, the space between the band and the pipe being filled up with lead and well caulked. The play between the band and the pipe is sufficient to admit of an angle of 2°. Large angles are turned by means of special bands and castings. Each length is well coated inside and outside with asphaltum and coal tar.

The 12-in. submerged main, under Burrard Inlet, was of the well-known Ward flexible joint pattern, and the contract for laying this main was let to Mr. JOHN F. WARD, of Jersey City, the inventor of this joint, in November, 1887. Mr. WARD commenced operations in April, 1888; but after pulling out 18 of the 105 pipe-lengths contracted for, he officially abandoned his contract under circumstances difficult to understand.

The failure of Mr. WARD to do a work which he had designated as easy of execution caused a delay of some months. But on July 9, the water company entered into an agreement with Messrs. H. F. KEEFER and D. MCGILLIVRAY, of Vancouver, wherein for a stated lump sum they would undertake to lay the pipes across the Narrows. They agreed to expend $10,000 on these submerged mains and forfeit this sum in case of failure.

The method adopted by these gentlemen is thus described in detail in the *Daily News Advertiser* of Vancouver:—

Messrs. KEEFER and MCGILLIVRAY, though entirely unaccustomed to this particular class of work, entered into the fulfillment of their contract with energy, entirely disapproving of the attempt made by Mr. WARD and his mode of procedure, and their first step was to undo all he had already done. The 18 lengths he had submerged were hauled back onto dry land. The general plan adopted by them was to joint all the pipes on dry land in one continuous row, and by the aid of powerful machinery pull the whole 105 lengths across the inlet at one time. A trench 3 ft. deep, 4 ft. wide and 1,200 ft. long was excavated on the line of the crossing on the north shore. Continuous runners of barked firs were placed in the bottom of this trench. On these runners 100 lengths (5 lengths having been found defective were discarded) of the flexible pipe were jointed in one continuous line. Each length was provided with a wrought-iron ring encircling the pipes, to which buoys of 500 lbs. buoyancy were attached. To the extreme south end of the line of pipes, that is the end nearest the water, was attached a large float built of cedar logs and capable of floating that end when immersed.

The hauling gear was as follows. To the north end, that is the end farthest from the water, was attached a 9-in. manila cable, 1,200 ft. long, which was connected with a 25 horse-power engine stationed at low-water mark on the same shore. To the middle length of the pipe was attached a 1¼ in. diameter steel cable, 1,876 ft. long, which connected with a 30 horse-power engine stationed on the opposite shore. Midway between the middle length of the line of pipes and the extreme south end, a similar steel cable 1,586 ft. long was attached. This cable connected with a 25 horse-power engine on the south shore. A third steel cable of the same diameter and 1,310 ft. long was attached to the extreme south end of the line of pipes, and this cable connected with two 25 horse-power engines on the opposite shore. It will thus be seen that there were no less than three heavy steel cables and one heavy manila cable attached to the line of pipes, and they were connected with engines aggregating 130 horse-power.

A few days previous to the work of hauling this long line of pipes across the inlet, the test pressure of 300 lbs. to the square inch was applied by means of a steam pump. Under this pressure, 8 lengths were found to have sustained fracture in a greater or less degree during their repeated handlings, and were consequently removed, thus leaving only 92 lengths, weighing, lead included, 55½ tons.

For the further information of the company, Mr H. B. SMITH, the resident engineer, again examined the bottom of the inlet, taking soundings at every 5 ft., and dragging the lead on the bottom all the way across. The result was in every way satisfactory.

On Aug. 28 last, at 10 A. M., the engines connected with the cables attached to the long line of pipes lying on the sideway on the opposite shore commenced to pull. Immediately the cables straightened out and remained taut and stationary, but only for a few seconds, for a sudden slackening took place, and the excited spectators were assured of the fact that the mains had started on their long journey across. Owing to the cramped nature of the ground where the engines were located, the blocks and tackle connecting the steel cables with the supports on land had to be overhauled every advance of 56 ft. that the mains made. The process of hauling was, therefore, necessarily slow, but at 7 P. M. the chief engineer announced that the Vancouver Water-Works Co.'s main had reached its destination on the south shore of the inlet, and that the great work of crossing the Narrows was an accomplished fact.

An expert and bold diver, Mr. LLEWELLYN, walked twice over the line of the submerged main, and reported that the whole line of pipes were lying in a perfectly straight line, without sag or bend; that the pipes as they were being pulled over, had cut a deep groove in the soft sandstone rock, and that already considerable silt had gathered above and below the pipes. He gave it as his unqualified opinion that in a few weeks the pipes would be entirely covered over, and that their permanency and safety was beyond question.

On August 30, in accordance with their agreement that the pipes should be tested after being submerged, the contractors applied in the presence of the company's engineers a final test pressure of 300 lbs. per sq. in. This proved entirely satisfactory. The pressure was steadily maintained for some minutes and the leakage under it found to be almost *nil*. The chief engineer then signified his final acceptance of the work on behalf of the company.

In continuation of the general sketch of the works, it may be said that the Vancouver distribution system includes 150 tons of 8-in. pipe, 300 tons 6-in. and 160 tons of 4-in., together with 23 tons of 2-in. and 1 ton of 2½ in. wrought-iron connections. The laying of this pipe, with all necessary gates, valves, etc., and 62 hydrants, is completed, and it is expected that the works will be in operation by April 1, 1889.

The general distribution plan was designed by Mr. THOMAS C. KEEFER, C. M. G. and late President of the American Society of Civil Engineers. The scale of the work and the methods of execution reflect much credit upon the engineers connected with it and in themselves indicate the energy and enterprise of this 3-years-old city.

THE RESHT-TEHERAN RAILWAY CONCESSION in Persia, granted 10 years ago, is the subject of some controversy. Baron REUTER, who held the original concession and paid $200,000 caution money which Persia now offers to return, wants his concession renewed. But the Russian Government demands a concession for Moscow capitalists for a railway from the Caspian Sea to Teheran, starting at Amol. And Russia will probably over-persuade Persia in this case.

Petroleum Fuel Tests.

Some very interesting and careful tests of the efficiency of petroleum as a fuel for locomotive boilers, showing very satisfactory results, were made by a Board of naval engineers last year, and are reported in the recently issued report of the Bureau of Steam Engineering, from which we make the following abstract.

The accompanying cuts make the nature of the apparatus clear, which is that of the Petroleum Fuel & Motor Co. of Washington, D. C. The oil is first atomized, or probably partially gasified, by highly superheated steam, after which it is supplied with a quantity of hot air within the pipe by which it is conducted to, but at some distance from, the burner. The apparatus as applied to a locomotive consists of the atomizer located below and secured to the floor of the cab; the oil pump, drawing its supply from a closed tank in the coal-box of the tender and forcing it through the atomizer and pipes to the burners; the air-tank and coil in the smoke-box for heating air, which is supplied by an ordinary Westinghouse air pump, which pump also supplies the air-brake system; the superheating coil for superheating steam for the atomizer, which is located inside the fire-box; the burners, and the air pipes for supplying air around and near the burners for the more perfect combustion of the atomized oil.

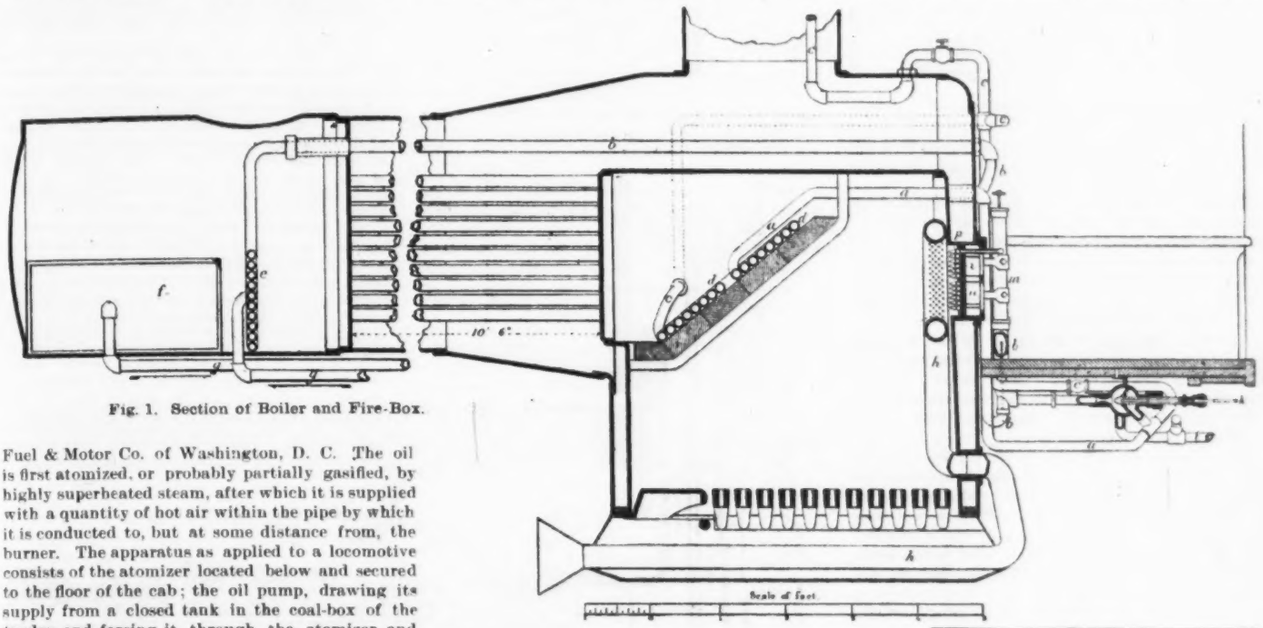


Fig. 1. Section of Boiler and Fire-Box.

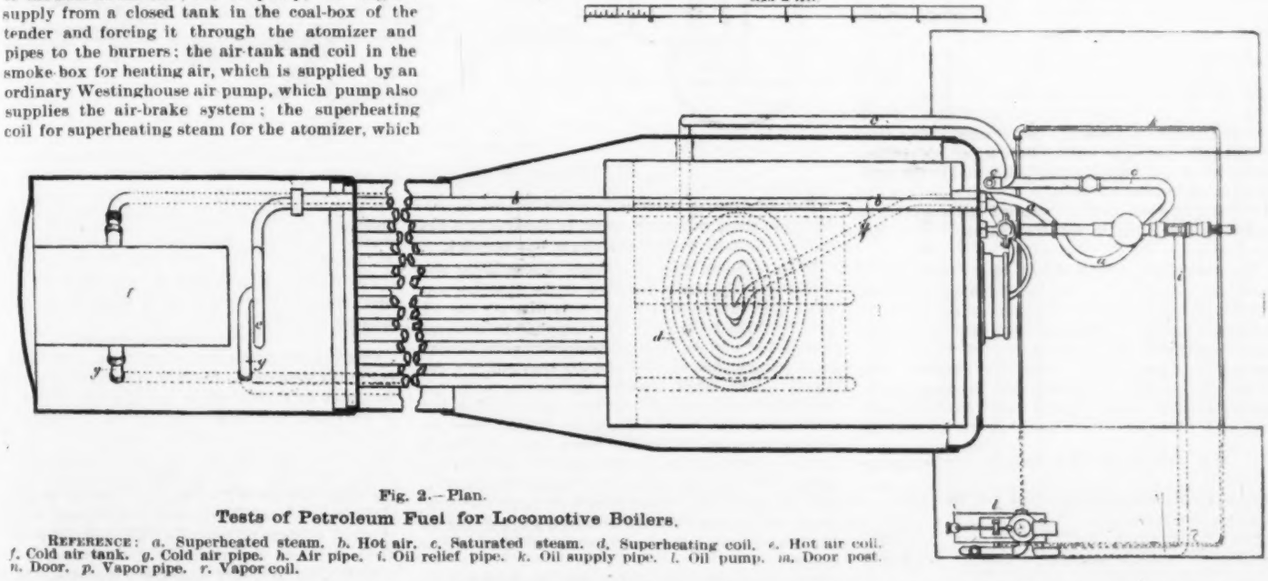


Fig. 2.—Plan.

Tests of Petroleum Fuel for Locomotive Boilers.

REFERENCE: *a*. Superheated steam. *b*. Hot air. *c*. Saturated steam. *d*. Superheating coil. *e*. Hot air coil. *f*. Cold air tank. *g*. Cold air pipe. *h*. Air pipe. *i*. Oil relief pipe. *k*. Oil supply pipe. *l*. Oil pump. *m*. Door post. *n*. Door. *p*. Vapor pipe. *r*. Vapor coil.

Figs. 1 and 2 show the general arrangement of these parts with a longitudinal section of the boiler. The atomizer, which is of peculiar construction, is shown in Fig. 3. It consists of a hollow globular casting 5 ins. in diameter, and divided into two parts by a curved diaphragm. Through a nozzle on one side passes a pipe 1¼ ins. in diameter which extends through the diaphragm and then narrows to a ⅛ in. opening. In the interior of this pipe and having the same axis is a second pipe ⅜ in. in diameter and narrowing to a 1-16 in. opening directly opposite the opening of the larger pipe. The superheated steam enters the globular part from below, and passes through a number of small holes in the larger pipe and jackets, the smaller pipe for a distance of 10 ins. The oil is supplied through the inside smaller pipe, being heated by the jacket, and passes in a jet through the 1-16 in. opening, and then with the superheated steam passes through the ⅛ in. opening in the end of the larger pipe. From the globular part, the atomized oil and superheated steam are conducted a distance of 20 ins. through a 1¼ in. pipe, and then upwards to the post of the furnace door, and thence to the burners.

At the bend the hot-air pipe is attached, the heated air being delivered through a ⅛ in. pipe extending upward to the hollow door-post. The door-post is so arranged with a packed joint that the door can be opened and closed readily without deranging the oil apparatus. The oil pump is conveniently located within the cab at one side, and arranged with a safety-valve and branch in its delivery pipe, so that when the oil pressure exceeds the limit set, the valve opens, and the excess of oil flows back to the tank from which it was drawn. The air-tank is a simple cylindrical drum to serve as a reservoir, and the heating coil is of ordinary iron pipe, bent to form, and set directly opposite the tube-ends in the smoke-box, so that the heat which it receives is only that which would otherwise be lost up the funnel.

The steam superheating coil is located within the fire-box and rests on an inclined shelf of fire-brick, which shelf protects it as well as the tube-sheet and tube ends from the direct action of the flame. A space over the top of the shelf, 8 ins. wide, and at the sides and bottom 2 ins. wide, permits the passage of the products of combustion to the boiler tubes. The coil is of copper pipe 1¼ ins. diameter with ⅝ in bore. The pipes supplying both the air reservoir and the superheating coil lead first to the cab, for the purpose of having regulating valve at hand, and then back to the coils, from which they lead directly to the atomizer.

The burners are placed on the lining plate of the furnace door. The burners proper are 124 in number and are in the form of hollow frustums of cones ⅝ in. at base and ¼ in. at the point, with ⅛ in. openings, and projecting 1⅛ ins. from the face of a flat casting. A second flat casting is faced and secured to the first one, and between the two is cut a spiral groove, in which the pipe from the door-post, supplying the atomized oil, is placed. Drilled into this pipe opposite each of the hollow conical projections are four 1-32-in. holes, and the pipe itself terminates near the middle of the casting with a screw plug which can be removed for blowing through.

The air-supply pipes have bell-mouth openings, pass under the grates on both sides, thence up into the fire-box, and entirely around and at a short distance in front of the burners. They are perforated on the side toward the flame. It is designed that these shall catch the air and force it up to the flame by the forward motion of the locomotive. A damper in the door performs the same office when the engine is backing. All the pipes through which the oil, either in the liquid or atomized form, passes, as

well as that for superheated steam, are of copper or of a composition of 90 per cent. of copper, and it is the use of this material, it is claimed, which prevents the deposit of solid carbon and consequent choking.

The principal proportions of the boiler were:

Grate surface		11.33 sq. ft.
Heating surface:		
Fire-box	72.88 sq. ft.	
Tubes	736.70 "	
Front head	6.24 "	815.82 "
Ratio of grate to heating surface		1 to 72 "
Area of opening through tubes		2.92 "
Ratio of opening to grate surface		1 to 3.88 "

The water used was taken from the city hydrant and was extremely muddy, so that the boiler water-legs, which were clean at the start, were filled from 8 to 10 ins. in depth with hard mud at the end of the trial.

On the trial two large casks were used for measuring tanks and their capacities accurately determined by weighing. The casks were placed on the roof of the box-car, and pipes from each led to the engine water-tank.

The steam was blown off at the safety-valve at the pressures shown below, and the steam for the calorimeter was taken from the boiler dome directly below and as near as possible to the safety-valve, the mouth of the pipe being directed against the current of the flow. This pipe led inside the box-car where the calorimetric tests were made.

The water was fed to the boiler by the injector, but all the overflow was caught and returned to the tank. Care was taken that there were no leaks or loss from any cause. As steam was required for the atomizer, it was necessary to start fires in the usual way with wood and coal.

Fire was started at 8.20 A. M., 247 lbs. of pine and 756 lbs. of anthracite coal (egg size) being used for this purpose. Steam formed at 10.10 A. M., and at 10.52 A. M., there being 75 lbs. pressure indicated by the gauge, the dampers were tightly closed, the surface of the coal in the fire-box covered to the depth of 2 ins. with refuse and earth, and the oil fire started. It was believed that the closing of the dampers and covering of coal would wholly eliminate any effect the starting fire might otherwise have, but to be doubly sure the oil fire was continued at full force until 11.20 A. M.—3 h. 10 m. from time of starting—before the trial proper was begun. At that time the taking of data, which were recorded half hourly, commenced. The trial lasted for 6 hours, or until 5.30 P. M., at which time the level of the water in the boiler and in the tank was the same as at starting.

Three barrels of oil were weighed and supplied to the tank and 4 ins. in depth additional used from the tank.

The steam pressure is shown by a detailed half-hourly table, to have varied but a few pounds from 108 lbs. throughout; the oil in pipe varied about 20 lbs. from 126 lbs. average, and the hot air in pipe was nearly constant at a pressure of 69 lbs. The atmospheric temperature was 69° Fah., the feed-water 67° Fah., and the gases in the chimney nearly constant at 557°; 19,945 lbs. of water were evaporated, and 1,327 lbs. of oil used, giving a result of

$$\frac{19{,}945}{1{,}327} = 15.03 \text{ lbs.},$$

and for the equivalent evaporation from and at a temperature of 212° we have:

Absolute pressure (p)	=	122.5
Total heat of steam at this pressure (H)	=	1,186.4361
Temperature of feed-water (t)	=	67.25
Total heat of water at temperature t, (h)	=	35.2616
Units of heat required to vaporize 1 lb. of water from temperature t, and under an absolute pressure p, $(H - h)$	=	1,151.1745
Units of heat required to vaporize 1 lb. of water from and at a temperature of 212°		965.7

Then $15.03 \times 1151.1745 \div 965.7 = 17.916$ lbs., which would be the true equivalent evaporation from and at 212° had the water been all vaporized, or had the product been dry saturated steam.

During the trial, five reliable calorimetric measurements of the quality of the steam were made, and the observed data and computed results calculated by the formula

$$Q = \frac{1}{i}\left[\frac{W}{w}(h' - h) - (T - h')\right]$$

gave results varying from 100 per cent. to 85 per cent. dry steam.

The average was 92.7 per cent. of dry steam and 7.3 per cent. of moisture which passed off with the steam.

To determine the correct potential evaporation and the actual heat units realized from the combustion of the fuel, as measured by the steam produced, we have the following data and computations:

Units of heat required to vaporize 1 lb. of water from 67.25° and under absolute pressure 122.5 =	1151.1745
Units of heat required to raise the temperature of 1 lb. of water from 67.25° to 342.61° the temperature due to the absolute pressure 122.5, 314.4726 − 35.2616 =	279.2110
Total pounds of water fed to boiler	19,945
Pounds of water vaporized, 19,945 × .927	18,489
Pounds of water raised in temperature, 19,945 × .073 =	1,456
Units of heat required to vaporize the water = 18,489 × 1151.1745 =	21,284,065.33
Units of heat required to raise the temperature of the water = 1456 × 279.211 =	406,531.22
Total units of heat derived from the fuel, as measured by the steam discharged	21,690,596.55
Units of heat per pound of oil, 21,690,596.55 ÷ 1327 =	16,345.59
Number of pounds of water of temperature 67.25° that would have been vaporized under an absolute pressure of 122.5 lbs. per pound of oil, or potential evaporation, 16,345.59 ÷ 1151.1745 =	14.199
Equivalent potential evaporation from and at 212°, 16,345.59 ÷ 965.7 =	16.926

This gives $h = 21{,}010.3$. The equivalent evaporation from and at 212° is

$$E = \frac{h}{965.7}$$

which gives $E = 21.756$ = lbs. of water.

The Board state in conclusion:

"Whence it appears that there was realized with petroleum in the device tested 77.8 per cent. of the total heat of evaporation of which it was theoretically capable which is a much larger proportion than is possible under any conditions of actual working practice with the best quality of coal. The facility of handling petroleum and manipulating the fires is very decidedly in its favor, and a much smaller force would be required for that purpose than with coal.

"The trial was not of sufficient duration to absolutely demonstrate the permanent efficiency of the device for burning petroleum, but an examination after its conclusion showed no evidence of any deposit of carbon in the pipes or burners, and certainly the heat and evaporative efficiency were as great at the conclusion as at the beginning. The representative of the company informed us that the device experimented with had been in use for 3 years, that it had not been cleaned, and that there had never been any evidence of carbon deposit.

"The question of safety in stowing and handling has not been decided, but in the opinion of the Board this could be satisfactorily provided for by the use of closed tanks, water-jacketed, with vent pipes overboard, and by careful workmanship in connecting pipes, fittings, and valves. We are of the opinion that the system could be advantageously adopted on board torpedo-boats and coast defense vessels, if safety in stowage and handling can be clearly arranged, and think the device of the Petroleum Fuel and Motor Company, of Washington, D. C., worthy of a trial, particularly as it can be applied without interference with the coal-burning arrangements."

The Board consisted of A. S. GREENE, Chief Engineer, and C. W. RAE and R. S. GRIFFIN, Assistant Engineers, U. S. N.

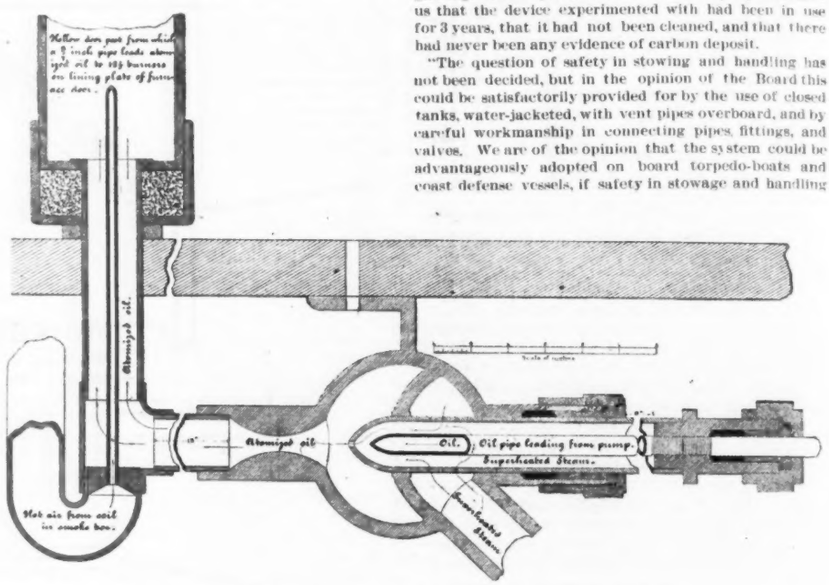


Fig. 3.—Atomizer of Petroleum Fuel for Locomtiova Boiler.

The oil fire was practically noiseless and smokeless, and there was no evidence, in the way of leaks or odor, to indicate that petroleum was burning.

It is probable that the high temperature and quantity of the steam supplied to the atomizer was more than sufficient to wholly volatilize all the oil, and that the heated air later supplied in the pipe was also of sufficiently high temperature to prevent any condensation, so that the fire was really a gas flame. Just what these temperatures were, the board had no means of accurately determining, but the superheated steam pipe, 30 ins. distant from its passage through the boiler front, was sufficiently hot to quickly melt and vaporize zinc, while at the atomizer it readily melted lead; hence the temperature of the steam must have been near 800° Fah. while the temperature of the heated air, judging by the touch, must have been above 200° Fah. within the pipe.

The quantity of air and steam required for the atomizer could not have been large, for the former was all delivered through a 1-16-in. orifice under a pressure of 57.7 lbs, and a moderate motion of the air-pump supplied it, while the latter, together with the entire oil supply for the fire, was delivered through a ⅛-in. orifice, the pressure being 107.5 lbs., and the difference of pressure on the two sides causing the flow being necessarily less than this.

The oil used was by analysis, $C = 84.08$; $H = 14.40$; $O = 1.52$. Specific gravity, 0.822. Flashing point, 64° Fah.

With the chemical composition of the fuel and the following formula, based on the experimental determinations of Messrs. FAVRE and SILBERMANN, we are able to compute the number of heat units that its complete and perfect combustion will produce:

$$h = 14500\left[C + 4.28\left(H - \frac{O}{8}\right)\right]$$

THE BARRY AUTOMATIC TRAIN INDICATOR, according to the Providence *Journal*, is a dial located at the height of an engine cab on top of a post by the side of the track, and facing the runner. Its purpose is to indicate to engineers the number of minutes which have elapsed since the departure of the last preceding train. The mechanism, as described in the manufacturer's circular, is a strictly first-class eight-day clock movement, warranted to run through winter and summer with such slight variations as in no way to affect the accuracy of the record. An auxiliary movement is attached to the clock, to swing in and out of mesh with it. When in mesh, the hand is carried to 25, and then stops; when out of mesh, the hand springs back to 0. The gradual slight depression of the track rail by the front truck of a locomotive moves a horizontal iron rod, which in turn depresses the upright rod, and through its connection and spring throws in and out of the mesh the auxiliary and clock movement. The signals are entirely of iron, and put in below the frostline. The parts on the ground are boxed and made water-proof. The headlight lights the signal sufficiently to enable the record to be taken by the engineer at any rate of speed.

EARTHQUAKE SHOCKS were felt at Rouett, Col., on Jan. 15. Some of the shocks are said to have been violent, and several masses of rock fell from the mountains. At the hot springs a quantity of water and gas was thrown out, causing an overpowering smell in the neighborhood.

Concerning Street Pavements.

BY CAPT. D. TORREY.

Why the business of street paving should be treated unlike other kinds of business, as it usually is, does not admit of a wholly satisfactory explanation. Probably it is due in part to laws which provide for raising money to meet the expense of pavement construction, laws which are founded upon misapprehension of the equity of taxes levied for such purposes. Whatever the true explanation is, the facts are that most persons count it as their individual gain if they can limit their liability for the paving of a street in front of their property by having laid any kind of cheap pavement, even one which is certain to cost extravagantly for subsequent maintenance and use. Such false economies may be avoided in part by being more widely understood.

The reduction of the cost of construction of pavements is most commonly effected by failing to secure an adequate foundation under them; also by neglecting to make them water-tight, so that they are subject to disturbance by frost, or from the softening by water of the underlying earth. These omissions, as all engineers know, insure quick returns in the way of uneven settling of the street surface, and the need of the consequent costly repairs. Owing to a confusion of ideas in the minds of the general public, it does not perceive that durability of paving material is a very different matter from that of durable pavements, and so it tolerates defective construction because the individual stone or other blocks remain sound.

Many otherwise intelligent people insist, in the case of some pavement which may be under discussion, that it is not worn out, simply because the stones are all there, even when not one stone can be found in its original position. What they do not see is the fact that a pavement is a construction as much as is a wall or a house. They would never think of calling a house or a wall serviceable because the brick and stone were all there, unless other conditions exist. Now, while most people know when a house or wall needs rebuilding, very few seem to be able to tell when a street pavement first needs remaking.

It is the purpose of this paper to submit to the reader the results of the writer's investigation of the problem of pavement expenses, as a means of ascertaining the relative economies of use, durability and serviceability of pavements. In doing this, attention is first called to the necessity of establishing, to the satisfaction of all persons interested, an acceptable definition of the condition in which a pavement must be, to condemn it as being worn out. It is demonstrable that pavements, like all other constructions, are worn out when in such a condition that their further use costs more than would their immediate renewal. This definition relates generally to the financial aspect of the problem; and does not include an intangible value of pavements, which finds expression in likes and dislikes, and is covered by the word "desirability." Between two pavements, alike in cost and durability, people will have preferences, arising from the condition of their health, personal prejudices, and various other intangible influences, causing them to select one rather than the other for use in their respective streets. Such selections are often made against the demonstrated economies of the case, and usually in ignorance of them. Whenever one kind of pavement is more economical and more satisfactory to use than is any other, there should not be any difference of opinion about securing it, either as new pavement, or as to the repairing, or in replacement of an old one.

The matters discussed herein are presented in a form intended to attract the attention of the owners of city property, who are specially assessed for the paving of their streets. The average width of city lots is taken to be 50 ft., and one-half the width of the average street between its curbs is taken to be 20 ft., making the area of street for which an average assessment is made 1,000 sq. ft.

Determination of Relative Economics.—The relative economies of pavements, whether of the same kind in different condition, or of different kinds in like good condition, are sufficiently determined by summing their cost under the following headings of accounts:

First.—Annual interest upon their first cost.

Second.—Average annual expense for maintenance and renewal.

Third.—Annual cost for custody (sprinkling and cleaning).

Fourth.—Annual cost of service and use.

Fifth.—Annual cost of consequential damages.

First.—The first cost of a pavement is, like that of a turnpike, plank road, or railroad, a permanent investment, measurable for purposes of comparison by the amount of annual interest on the sum expended. Thus, as an illustration of the application of this measure of comparison, the annual tax due to the original cost of pavements, assuming the worth of money to be 5 per cent., a pavement costing $2.79 a sq. yd., entails an annual interest loss or tax of $0.1395; and 1,100 sq. ft. of it, an interest tax of $15.50, being 5 per cent. upon the $310 which it costs.

Second.—The average annual expense for maintenance and renewal of a pavement is to be determined or calculated for the unit of the area as given above (1,000 sq. ft.). Attention is called to the fact that the only way of arriving at a legitimate determination of these expenses, is to include all outlays for repairs and renewals, which are made from the time when the pavement is new and at its best, to a time subsequent, when by any treatment it is again made in equally good condition. The gross sum so derived, divided by the number of years which elapse between the two dates, gives an average annual cost for maintenance and renewal.

The usual error in determining current repairs arises from the general failure to properly maintain pavements. For purposes of comparison, all pavements must be equally well maintained. Whenever even a single square foot of pavement is so bad that if the whole of it were in like condition, the whole would be condemned, then of course that particular square foot should be condemned and put in good condition. This is very rarely done, and in consequence there are many pavements in our cities which are liable for maintenance expenses never incurred, and consequently never charged up against them. These pavements are, therefore, held in false estimation, as being subject to light current expenses.

Third.—Any pavement, to be considered as properly cared for, must be kept dustless and clean. While circumstances legitimately determine in many cases that streets may be cleaned at daily, weekly or semi-weekly intervals, the only admissible condition for the purpose of this analysis of street expenses must be that of like requirement in both or all cases subjected to comparison. The cost of cleaning and sprinkling is to be calculated for 1,000 sq. ft.

Fourth.—The annual cost of service of a pavement is made up by combining several items of cost incidental to the use of streets for traffic. For instance, such as limitations of the speed of movement, as in case where a bad pavement causes slow driving and the consequent loss of time; or cases where the condition of a pavement limits the weight of the load which a team can haul, and so compels the making of more trips, or the use of more teams, or cases where it causes greater wear and tear of vehicles, of equipage and of horses.

If a vehicle is run 1,500 miles in a year, and its maintenance costs $30.00 a year, then the cost of its maintenance is 2 cts. to the mile run. If the value of the team's time is, say, $1.00 for the legitimate time taken in going 1 mile with a load, and in consequence of bad roads it takes double that time, then the cost to traffic from having to use that 1 mile of bad street is $1.00 for each load. The same reasoning applies to circumstances where the weight of load has to be reduced so as to necessitate the making of more than one trip. Again, bad pavements lessen not only the life service of horses, but also the value of their current service.

The unit of these accounts is obtained by first finding the cost per mile of distance traveled, which cost divided by 5,280 and multiplied by 1,000 gives the desired result.

The writer investigated the cost of wear and tear of vehicles upon the rough pavement of one street having an annual traffic of 23,400 vehicles per foot of street width. The result of a long investigation was the conclusion that in using that street there was an amount of wear and tear of vehicles which would average, in money value, over 1 ct. per mile per vehicle beyond what would be the case with the very best suitable pavement.

Now 23,400 vehicles moving over 1 sq. ft. give 23,400,000 ft. of movement for 1,000 sq. ft. of pavement, which divided by 5,280 ft. in a mile, gives 4,432 miles. This at 1 ct. per mile for such excess of wear and tear of vehicles, gives $44 32, or about 15 per cent. (annually) upon the cost of a new pavement. It is probable that if all the elements of pavement economies named above were taken into account, it would be determined that in this particular instance the annual sacrifice for using the old pavement was fully ⅓ the total cost of a new one.

Fifth.—The determination of consequential damages, arising from the use of defective or unsuitable pavements, involves the consideration of a wide array of diverse circumstances, only the more important of which are here mentioned.

Some pavements, when in their best condition, are rough surfaced, and so give lodgment to dirt which cannot be swept off. Such pavements require constant sprinkling to prevent dust from rising when the wind blows. The muddiness occasioned by the sprinkling is some disadvantage under any circumstances, and a material one on streets devoted to retail trade. If that particular disadvantage be appraised at so small a sum as $1.50 per month, or 6 cents per day, it exceeds the annual interest cost of the best quality of pavement, free from the disadvantage under consideration.

Rough surfaced pavements are noisy under traffic and insufferable to nervous invalids; and much nervous sickness is attributable to them. To all persons interested in nervous invalids, this damage from noisy pavements is rated as being far greater than would be the cost of substituting the best quality of noiseless pavement. But there are, under many circumstances, specific financial losses, measurable in dollars and cents, dependent upon the use of rough, noisy pavements. They reduce the rental value of buildings and offices situated upon streets so paved—offices devoted to pursuits where in exacting brain-work is required. In such locations quietness is almost indispensable, and no question about the cost of a smooth pavement weighs against its possession.

Another consequential damage arises from neglected sanitary conditions. Unless a pavement is filth-proof, it is, next to bad sewers, the most efficient agency within a city for generating and disseminating noxious vapors and disease germs, now recognized as the cause of a large part of the sickness troubling mankind.

Definitions.—There is some confusion in the use of the words "durability," "serviceability" and "desirability," in speaking of street pavements.

The durability of a pavement is its quality, which relates to the length of time during which it is serviceable; and the relative durability of pavements is determined by comparing the gross tonnage of traffic over them, without regarding the cost of the service.

The serviceability of a pavement is its quality of fitness for use, and a comparison of pavements in this respect is effected by determining the tonnage of traffic which each will bear for some amount, say one cent of annual cost.

The desirability of a pavement is its possession of qualities which make it satisfactory to most people seeing and using it. A comparison of pavements in this respect must be made by taking into account their estimation in the minds of people who conduct traffic over them, also certain sentimental or intangible considerations, like those arising from witnessing cruelty to animals, which many persons feel who do not use the streets. Popular prejudices about pavements affect the prices of real estate upon paved streets and so help to determine their desirability.

A pavement so rough that traffic is kept off the street might be a most durable one, but certainly would be lacking in serviceability. In a general way of speaking, the value of city property depends upon the volume of the traffic in the street upon which it is located. Ordinarily a pavement is not wanted by the owners of property on the street, however durable it may be, if it lacks in serviceability, and they may not want it, even when it is serviceable, if it is not also popular.

In comparing pavements, no traffic should be

counted after the time when a pavement is in such a condition that its use will cost more than its renewal, as previously explained. Nor should a pavement be credited with traffic unless it is kept clean and in good repair; for an inch of dirt will protect it from abrasion for an indefinite period of years.

Guaranteeing Pavements.—To secure pavements that shall be durable and serviceable, the municipal authorities often require the contractor to guarantee his pavement for a term, usually, of five years, under provisions calling for maintenance in good condition during that period of time, and for final delivery in good order. Such contracts involve two kinds of service, that of construction and of maintenance for a limited period. In the latter the conditions are exacted indiscriminately, alike on streets with heavy traffic and on those with very light traffic and thereby become sometimes burthensome, unless the same contractor paves so many streets of all kinds as to correct the inequality by securing a fair average traffic condition. The correct policy to pursue in contracting for maintenance would be to measure the service of the pavement by tonnage rather than by years. To do this equitably, the city needs information about the traffic, which it can obtain only by having a census of it taken, as experience shows can be readily done.

Many contracts for street pavements, in some European cities, have provided for the construction and for the maintenance of the pavements for long terms, say, of twenty years, payments to be made in equal annual instalments throughout the term. Such arrangements appeared at first to be very favorable, owing to the first payments being so much less than they must otherwise have been for the whole cost of construction. The *pro rata* annual payments provided for the interest and risks of various kinds, with contractor's profits thereon in addition to the direct outlays for construction and repairs, so that the final outcome was unsatisfactory to both parties to the contract.

The prevailing custom in this country is to pay the cost of construction of a pavement as soon as completed. Two methods of meeting the expense of maintenance are followed. In one the municipality meets the annual requirements as they occur, and in the other a contract is made for a term, say, of ten or twenty years, by which the contractor, for equal annual payments is required to keep the pavement, and turn it over to his successors, in good condition at the expiration of the contract.

This annual payment has to cover the contingency of the contractor being at the expense of completely renewing the pavement.

The equal annual amounts paid on contracts for maintenance, as just explained, include two funds, one of repair accounts and the other a sinking fund, intended to meet the cost of renewing the pavement, which must be done if the contract is for a long term of years. If an attempt is made to separate for each year the proportion of the annual payment which should provide for each of the two purposes, it would be found that the earlier years would be contributing little or nothing for repairs, as the pavement being new, they would not be required, but the proportion so applied would increase gradually, and at last consume nearly all the current annual payment.

The justification of contracts for the continuous maintenance of street pavements is in the advantage gained from having some one admittedly responsible for their condition, and more amenable to discipline than are city officials for neglect. With this consideration in mind, each community can determine whether it is to its advantage or not to contract for such maintenance.

Traffic Census.—With a view to help bring about a reformation of municipal policy in the matter of street paving, and in contracting therefor, it is desirable that city engineers shall determine the tonnage of traffic upon a few streets in each city, comprising such typical cases as will enable them to classify all their streets. The account should be taken for seven consecutive days in each case, and from 6 or 7 A. M. to 6 or 7 P. M., as the 12-hour period gives the most satisfactory result. In some cases the counting should be repeated at different seasons of the year to insure approximate accuracy in making estimates. The work can be done usually by assistants, so as not to entail much if any expense, and it would prove of a value thousands of times greater than the cost of gaining the information.

The writer had an account of traffic taken for several streets some time since, in which the method followed in making the record was by pencil entries upon large blanks held upon a writing tablet. These blanks were prepared with suitable headings, designed to keep that classified account of the traffic which it was thought desirable to obtain. It was found to be practicable to enter upon one sheet all the traffic of one day. A reduced copy of the blank is as follows:

TRAFFIC CENSUS.

Of ..... *Street, March* 188

CLASSIFICATION.	6 to 7	7 to 8	8 to 9
VEHICLES UNDER 1 TON—Walking			
Trotting			
Speeding			
TOTAL			
VEHICLES 1 TO 3 TONS—Walking			
Trotting			
TOTAL			
VEHICLES OVER 3 TONS—Walking			
Trotting			
TOTAL			
TOTAL NUMBER OF VEHICLES			
HORSES UNATTACHED—Walking			
Trotting			
Speeding			
TOTAL HORSES UNATTACHED			

The spaces between the lines, "Walking," "Trotting," "Speeding," were varied according to the volume of the respective classes of traffic. The column lines were drawn at the end of the hour.

The following is a copy of the instructions guiding the persons taking the records:

Vehicles, up to one ton:
- One or two-horse carriages, empty or loaded.
- One-horse wagons, empty or light loaded.
- Two horse wagons, empty.
- One-horse carts, empty.

Vehicles, from one to three tons:
- One-horse wagons, heavy loaded.
- One-horse carts, loaded.
- Two-horse wagons, light loaded.

Vehicles, over three tons:
- Wagons and trucks, drawn by two or more horses and heavy loaded.

Note especially, unusually heavy loads, such as six-horse trucks loaded with stone or iron, and give estimate of their weight.

In checking vehicles, use figures denoting the number of horses attached, and keep a separate list of horses unattached. All entries to be in groups according to gait.

To obtain the tonnage, light weight vehicles were estimated to average one half ton each (including the loads), the medium weight two tons, the heavy weight four tons, and horses one-half ton. Multiplying the total number of vehicles in each class by these figures and adding together the products, the total vehicle tonnage was obtained, and dividing this by the width between curbs, and the number of days of observation, we get the daily average vehicle tonnage per foot of width. This is the standard or unit of comparison.

The horse tonnage is treated in the same way.

The Poetsch Freezing Process in America.

The Poetsch-Sooy-Smith Freezing Co. is at work on a shaft for the Chapin Mining Co., at Iron Mountain, Mich. In sinking for a newly-discovered mineral ledge, quicksand was struck at 15 ft. below the surface and another and larger stratum of the same was located 60 ft. below the surface. The final result of this discovery was a contract with Gen. WM. SOOY SMITH and his company, the American owners of the Poetsch freezing process, to sink a 15 ft. shaft to a depth of 100 ft., some time last fall. The plan adopted was the same practically as that already several times described; but as this is the first American trial on any considerable scale, we will describe it in more detail, as reported in the Chicago *Tribune*.

Around a circle 29 ft. in diameter, 26 10-in. holes were bored in the ground. The task was not an easy one, the soil being full of stones and bowlders. Into these holes were inserted 8-in. wrought-iron pipes, connected with malleable iron couplings and securely plugged at the bottom. Inside of these large pipes is a 1½ in. pipe, terminating within 10 ins. of the bottom. At the top both series of pipes are connected with tubing of their respective diameters, which tubing leads to a couple of huge tanks in the freezing plant and engine house. The ice machine operates on a solution of chloride of calcium, reducing its temperature to minus 25° Centigrade, or about 17° Fahrenheit below zero. This cold fluid is forced into the series of small pipes dropping to the base of the large pipes. The pressure forces the liquid up the pipes and back into a tank, from which it again passes through the ice machine and is again sent on its congealing mission.

The result of the continued circulation of this cold solution is the absorption of the natural heat of the ground and the freezing of the earth around the pipes. These congealed circles gradually widening, form a solid, impervious wall, in whose frozen embrace the treacherous quicksand becomes as granite. Such was the discovery of Prof. POETSCH.

The Iron Mountain shaft is already down over 70 ft. The ice machine was set in motion Nov. 20. The ground began to freeze 24 hours later. A solid wall was formed Nov. 24, but it was not until Nov. 27 that Mr. THOMAS, the superintendent, decided to commence the work of excavation. Mr. THOMAS has kept an elaborate record of temperatures, lines of radiation, and other data which will prove of great value to engineers in future work of this kind.

From the examination made it was found that the ground at a distance of 70 ft. from the mouth of the shaft is frozen solid in a circle 15 ft. in diameter. In other words, the excavation is surrounded by a congealed wall over 14 ft. thick.

The original process has been much improved in its details since it has fallen into the hands of its present American owners, and in the past two years several patents have been taken out covering these improvements. The work at Iron Mountain is so far a thorough success, and the quicksand is being literally quarried like solid rock. The quicksand stratum here penetrated is of an unusually dangerous character, the particles, when separated from the water, being as fine as dust.

Brick Street Pavements.

At the late Memphis meeting of the National Association of Brickmakers, a paper on the general subject of brick street paving, by Mr. J. J. W. BILLINGSLY, was read. As this is a subject concerning which we have had several inquiries lately, and one in which many are interested, the following abstract is presented:

Latterly, in this country, the use of brick for paving streets has been receiving some attention. Sixteen years ago, at Charleston, W. Va., they put down a few squares of brick pavement, which have been subjected to heavy travel, and we are informed that they have stood the wear well. Since they have tested them they are generally improving their streets by paving them with brick.

At Steubenville, O., they have had a test of 8 years on the principal street of that city. The endurance so far has exceeded the most sanguine expectations. The writer visited Steubenville in May last and examined the street that was first paved and was agreeably surprised to see that it looked as though it had been laid only a year or two. The wear of 8 years was hardly perceptible.

Fourteen years ago Mr. HEAFER, of Bloomington, Ill., laid one square of brick pavement on the west side of the Court House. The writer has frequently visited that city since that time and has examined the pavement, finding it all that could be desired. Since they have been convinced of its merit, the city authorities have improved several of their principal streets in this way.

We are informed that Galesburg, Lincoln, Peoria, Springfield, and other cities in Illinois, have put down many miles of brick pavement. Decatur, Ill., has several miles of streets paved with brick, to the writer's own knowledge. In fact, all of their principal streets have been thus improved. This city commenced the use of brick 8 years ago. At one time they had 5 miles of their streets and sidewalks under contract for brick pavement. In Ohio brick is being generally introduced in the smaller towns and cities—at Columbus, Cleveland, Akron, and other places.

We have heard of no dissatisfaction where hard-burned brick have been used. We heard of one square that was paved in part with soft brick, in Columbus, Ohio, by some interested stone contractors, that was taken up and replaced with West Virginia hard burned to keep up the reputation of the pavement. Within the past year a section of one of the principal streets in Washington, D. C., has been paved with West Virginia paving brick.

It is no innovation of the past decade of years. It is no new-fangled invention gotten up by hard-pressed brick makers to tide over a dull period in their business. It is not a new thing in this country, and it is less so in the Old World.

Prof. ROBERTS, of Cornell University, N. Y., a year ago, in a conversation with the writer, said: "I wonder that our people do not use more brick in the improvement of our streets and highways. In the Netherlands the highways are generally paved with brick. In a ride of several days through the country, visiting various herds of Jersey cattle, I did not drive over more than 6 or 8 miles of dirt road. Some of the highways have been paved for more than half a century, and they require little repair and make splendid roads to travel over."

The brick should be hard and not easily chipped or crushed. There is no denying the fact that some clays are better adapted to the manufacture of pavers than other clays, but it is also true that in many localities clays may be found that are well adapted to this use,—clay that will burn to a hard body, having a tough fibre, (if the term "fibre" is admissible in distinguishing the adhesiveness or toughness of the product).

There are large brick plants in Eastern Ohio and West Virginia that make a specialty of the manufacture of paving brick. We are further informed that they make a specialty of the manufacture of pavers at Galesburg, Ill. The Decatur Tile & Brick Works, of Decatur, Ill., manufacture them in large quantities. But it is also true that in the burning of common brick a great many pavers might be selected from the kilns. We feel free to say that clays well adapted to the manufacture of this desirable product are so abundant that no one manufacturer is likely to have a monopoly of the business in any very large section of the country.

Brick pavements are desirable for the following reasons:

1st. They make a smooth pavement over which heavy loads may be drawn without a jolt. Draft horses are able to draw a third larger load over such a pavement than over a bowlder or rough stone pavement. In addition, both team and wagon are subjected to less wear. For light vehicles there is a most striking comparison. It is a pleasure to sweep along without a jolt or a jar over the smooth, springy brick pavement, and a tribulation to drive over the cobble or rough stones.

2d. Brick pavements are desirable because they are durable. The many instances already referred to are sufficient without adding another.

3d. The abundance of the material that is at hand—every street, sidewalk and highway may be paved with brick, and an abundance of material would be left in store.

4th. Brick pavements are easily repaired. There is not a pavement that can be named that can be so easily repaired as brick. If a single brick is too soft, replace it with another, and the work is done.

5th. Brick pavements are less expensive than others, if durability, wear and tear of teams, vehicles and comfort are taken into account. The cost of construction ranges from $1.00 to $1.40 per sq. yd.

To construct such a pavement properly, the roadbed should be first of all crowned a little and well underdrained; no springy or spouty places should be allowed to interfere with the solidity of the foundation. This may be done with a tile drain at the foot of the crown, on each side of the roadway or street. To a solid roadbed add 3 or 4 ins. of sand, then a layer of brick laid flat, 2 ins. more of sand, followed with a layer of brick set on edge, and the interstices filled with sand, and a small covering of sand on top. The latter will soon wear off. Another method is to set one layer of brick on the 4 ins. of sand, and settle with mauls and cover with sand as before. This is the cheaper method and is good enough. Where sand cannot be had in sufficient quantity, the bed for the brick is made smooth and even and soft, or pulverized for 1 or 2 ins. on the surface, the brick set on edge and settled a little, and the joints or interstices filled with the fine earth. Again, others use plank laid upon a roadbed brought to the desired grade, placing the plank upon sand or upon a clay bed, setting the brick on edge in a light layer of sand, then filling the interstices as before.

THE MOUTH OF THE BRAZOS RIVER is to be improved, and Mr. E. L. CORTHELL is the engineer. According to an interview with Mr. THOS. G. HURLEY, of Fort Worth, the average depth over the bar is now 6 ft., and this is to be deepened so as to convert the river into a harbor for some miles up from the mouth. The contract is let to a Mr. WILKIE, and it should be completed in two years.

Brake Tests of Boyden Power Brake.

The Boyden brake is in substance an air brake which uses a direct pressure of air to hold the brakes off, and a spring to apply them when its action is not resisted by the air pressure. Thus an automatic action is obtained without resort to any substitute for the Westinghouse triple valve, by which a fall of pressure in the main train-pipe is caused to open a connection between the auxiliary air reservoir and the brake cylinder. The principle is of course an entirely feasible one, but the efforts to embody it in practical form heretofore have not been particularly successful.

The Boyden Brake Co., however, whose catalogue is noticed in another column, have devised a complete system of brake gear which they claim is in all respects independent of the Westinghouse patents, and which certainly seems to have ingenious and meritorious features; and in December last a test was made on the Baltimore & Ohio Railroad with the results shown in the accompanying table, to which we have added a final column giving the comparative efficiency of the brakes in terms of the per. cent of the retarding force to the *total* weight of the train. To make this per cent. precisely comparable with that for other tests it should be the per cent. of the retarding force developed to *the load on braked wheels* and not to the total weight, since unbraked weight varies greatly. The records do not enable us to determine precisely what the unbraked weight of the train was; but we infer it was only the load in the engine truck, which would amount to only 1 or 2 per cent., but it may have been more.

All the trains (except No. 11) consisted of an engine 55 ft. long, weighing 82 tons including tender, of which perhaps 7 tons was on the engine truck, 2 private cars 120 ft. long and weighing 52.5 tons, and the remaining cars refrigerator cars weighing 18.2 tons (all of 20,000 lbs.) and 37 ft. long each. In test 11 the private cars were cut off. In tests 2 and 10 the engine was cut off. This leaves from 9 to 25 refrigerator cars as the test train proper. The cars were all coupled with the Janney coupler, except the two coaches, which had link and pin coupler. The two coaches were at the rear of the train and fitted with the Westinghouse automatic brake. The brake pressure used is stated to have been 50 per cent. of the total weight of the car, which is certainly very moderate. The tabular record was prepared by Mr. P. H. IRWIN, Resident Engineer.

The pith of the record is the last column giving comparative efficiency, which must certainly be regarded as creditable for a first formal test. They may be compared with the results of the first series of Burlington brake tests (1886) which were as follows:

Comparative Per Cents. of Brake Efficiency.

	Engine only.	Eng. & 25 cars.	Hand train brakes.
Westinghouse	9.88	9.40	4.08
Eames	10.46	7.14	
American	12.34	5.89	3.10

In the second (1887) series of tests, however, the Westinghouse immensely improved this record, running up as high as 17 per cent. efficiency with 50 car trains, about the ultimate limit of possible efficiency. In ordinary operating few stops are made with a higher efficiency than 6 or 8 per cent.

The formula by which the last column is computed is given on p. 337 of the "Economic Theory of the Location of Railways" under a table of "velocity heads" due to various speeds and is:

$$\frac{\text{Vel. head}}{\text{Distance}} = \left\{\begin{array}{l}\text{Grade of retardation in per cent. as given in table herewith} \\ \left\{\begin{array}{ll}+ \text{ dec. grade } \% & \\ - \text{ asc. } \quad " \quad " & \end{array}\right\} \pm \text{grade of repose or rolling fric. } \%.\end{array}\right.$$

The grade of repose was assumed to vary from 0.45 to 0.7, or from 9 to 14 lbs. per ton at the varying speeds. To determine the true per cent. of efficiency we should have:

$$\text{True efficiency} = \frac{\text{Grade of retardation}}{\text{p. c. of total wt. on braked wheels.}}$$

The speeds, brake pressures, etc., were determined by the Resident Engineer's test car, which was one of the private cars attached to the train. If this car had no brakes, there would have been perhaps 10 per cent. of the total weight unbraked, which would increase all the tabular efficiencies by nearly 10 per cent. It is an extraordinary fact that this very essential element of the record, the per cent. of weight unbraked, is almost invariably left out of brake test records.

We will not now attempt to describe in detail the Boyden mechanism, which is claimed to be throughout entirely new from the air pump to the brake cylinders. It is claimed that speed can be perfectly controlled down hill without any substitute for a pressure retaining valve.

Combined Adhesion and Rack-Rail Railroads.

The Austrian Government in adopting, in May 1888, plans for the construction of two railroads on the combined adhesion and rack-rail principle, set forth some of the advantages of this system along with other features of interest to engineers. From these the following abstract is made:

On mountain railways with gradients exceeding 1:30, built on the ordinary adhesion principle, the expenditure for local traffic would be certain to exceed the receipts. For such roads the experience on the Harz Railway and the Hollenthal Railway in Baden tends to show that a mixed system is the most advantageous; and on these lines the locomotives are constructed to run with equal facility over the ordinary rails or a cog-wheel section. It should be remembered, too, that with the rack-rail the adhesive force of the engine is also turned to good account, and on the latter a locomotive, with a train of equal weight, can ascend a steeper gradient than on the adhesion railway: the proportions varying from 1:33 to 1:40 on the latter and 1:15 to 1:18 on the former.

The cost of the mixed system, under the given conditions, will be from 30 to 50 per cent. cheaper than the ordinary adhesion system, according to circumstances; and the safety is certainly equal to that of an adhesion road with very steep gradients.

The report says that while, on account of its more elaborate mechanism, the engine for the mixed system consumes in coal, oil and maintenance about 3 cts. more per mile than the common adhesion engine, expert engineers have demonstrated that even the most powerful of the latter type cannot haul a load of 135 tons to a height of 1,000 ft. up a grade of 3 per cent. in less than one hour; while an Abt engine of the combined system will haul a load of 200 tons to the same height in the same time.

One of the Austrian lines referred to is 12 kilometers (7.44 miles) long; and the additional expense of an Abt combined engine (figured at 2 cts. per kilometer), allowing for four trains daily each way, including oiling of cogs and extra guard, is estimated at a capital investment of $3,500 per annum, at 4 per cent. per kilometer of railway; or say $5,600 per mile.

To this must be added the cost of the rack-rails and rack mechanism, which is estimated at $7,500 per kilometer. So that 1 kilometer of rack-rail road would cost about $11,000 *more* than the same length of ordinary road; or say $17,700 per mile. The cost of working the rack-road would of course be considerably more than on an ordinary road.

On the other hand, it must be considered that a line with gradients of 3 per cent. would be nearly twice as long as one with 6 per cent. The average cost of constructing the mountain sections of such railways as the Brenner, Semering and Arlberg, exclusive of the great tunnel on the latter, was about $137,000 per mile; consequently the additional expense mentioned above would be trifling in comparison.

Besides the two Austrian roads worked on the Abt system, there are the following: The Harz railway, normal gauge, 18.6 miles long, of which 4.8 miles are rack-rails. The maximum gradient is 6 per cent. The Bolan Pass railway has gradients of 4.2 and 8 per cent.; and the Venezuela railway, 35.3 miles long, is narrow gauge, and has a maximum gradient of 8 per cent. In the latter case even gradients of 2 per cent. have to be worked on the rack principle, owing to climatic conditions, and to the fact that at times swarms of locusts settle on the rails and reduce the adhesion.

ST. LOUIS ELECTRICAL WIRES are to go underground. A special committee of the Municipal Assembly of St. Louis has investigated the systems in use in Chicago, New York and St. Paul, and recommends the Dorsett system, and the passage of the bill granting a franchise for a subway, now before the Assembly.

ENGINEERING NEWS

AMERICAN RAILWAY JOURNAL

Published Weekly at Tribune Building, New York.

VOL. XXI. Saturday, February 2, 1889.

D. McN. STAUFFER, A. M. WELLINGTON.
EDITORS.
GEO. H. FROST. - - - - - BUSINESS MANAGER.

Subscription. — UNITED STATES AND CANADA, $5.00 *per Year*; $2.50 *for Six Months*; $1.50 *for Three Months*; *Single Copies*, 12 *cents*. FOREIGN COUNTRIES, $6.50 *per Year, or* 3 *cents per number additional.*

Drawings and Photographs *of all new engineering works or designs, large or small, of interest from their magnitude, novelty or originality, as well as newly adopted* **Standard Plans** *for engineering, structures or details, rolling stock, etc., are always desired for early publication. Also,* **Brief Technical Notes** *of the cost or manner of executing work, tests of materials, machines or other new devices, and* **News of New Construction** *of all kinds.* **Letters** *for publication must be accompanied by the name or card of the writer.*

Drawings for publication *should preferably be in plain black and white, considerably larger than they are expected to appear, with letters and figures in pencil only, all lines clean and bold.*

Coming Technical Meetings.

Engineers' Club, Philadelphia, Pa.—Regular meeting, Feb. 2. Secy. Howard Murphy, 1122 Girard St.

Engineers' Club of Kansas City, Mo.—Regular meeting, Feb. 4. "The Details of Iron Highway Bridges," E. W. Stern. Secy., Kenneth Allen, Y.M.C.A. Building.

Western Society of Engineers, Chicago, Ill.—Regular meeting, Feb. 6. Secy., John W. Weston, Gaff Building.

American Society of Civil Engineers, New York.—Regular meeting, Feb. 6. Secy., John Bogart, 127 E. 23d St.

Engineers' Club of St. Louis, Mo.—Regular meeting, Feb. 6. "Rainfall and River Discharge in the Mississippi Valley", Prof. F. E. Nipher; "Adding Machines", N. W. Perkins, Jr. Secy., Wm. H. Bryan, 709 Market St.

Civil Engineers' Club of Cleveland, O.—Regular meeting, Feb. 12. Report on Applied Science. Secy., James Ritchie, Case Library Rooms.

New England Railway Club, Boston, Mass.—Regular meeting, Feb. 13. Boston & Albany passenger station.

Engineers' Society of Western Pennsylvania, Pittsburg, Pa.—Regular meeting, Feb. 19. Secy., S. M. Wickersham, Penn Bldg.

American Institute of Mining Engineers.—The 53d meeting will be held at New York, on Feb. 19. Secy., R. W. Raymond, 13 Building Slip, New York.

Boston Society of Civil Engineers, Boston, Mass.—Regular meeting, Feb. 20. Secy., S. E. Tinkham, City Hall.

New York Railway Club.—Next meeting Feb. 21. Rooms, 113 Liberty St., New York City.

THE President's address, delivered before the Canadian Society of Civil Engineers and published in part by us last week, was improperly accredited to Mr. THOMAS C. KEEFER. It was delivered by SAMUEL KEEFER, late President of the Society; though both of the gentlemen named have served in that capacity. This fact, the omission of any name on the address as received at this office, and the temporary absence of those members of the staff who knew better, caused the slip referred to.

THE solutions so far received to the geometrical problem which we published Jan. 26 have all been by analytical geometry, by which it is far easier than by geometry, although not so very easy. We postpone publication of answers, that any who wish may send in geometric solutions.

THE meeting of the Presidents of Western railway systems, to adopt the plans for the proposed Interstate Railway Association, has been the most important event of the week in railway and financial circles. After a session of several days, the meeting adjourned on Jan. 30, subject to the call of the chairman, having adopted in substance the plan originally reported by the Executive Committee.

All the companies which it was proposed to include have taken part in organizing the Association except the Illinois Central, which has refused to join, on the ground that existing agreements are strong enough if enforced, and that its Southern system would receive no benefit from the proposed organization. The officials of other companies have shown a very commendable willingness to ignore rivalries and make concessions for the sake of harmony.

The traffic to be covered by the Association's agreement is to be all business competitive between its members, originating at or destined for points in the States of Illinois, Iowa, Missouri, Kansas, Nebraska, Colorado, Wisconsin and Minnesota, and the Territories of Utah, Wyoming, Dakota, New Mexico, Montana and Indian Territory, with the exception of Pacific coast business, covered by the Transcontinental agreement, Texas business, covered by the International Association lines, and business between points north of the Ohio and south of the Ohio.

There are to be 22 companies in the Association, and the agreement only awaits the signature of the President of each company to go into operation. The original "Presidents' agreement of Jan. 1, 1889" is placed at the head of the Articles of Association but separated from the present agreement. The minimum penalty for violation of any rule of the Association is changed to $100 instead of $250; but the company in fault must forfeit the revenue which it has secured by the violation. The agreement is to be absolutely binding until April 1, 1889. After that date any company wishing to withdraw from or amend the agreement must give at least 30 days notice.

One of the most important steps taken by the meeting was the unanimous agreement to offer the chairmanship of the Association to Mr. ALDACE F. WALKER of the Interstate Commerce Commission. It is not yet known whether he will accept or not; but should he do so, it will be one of the best possible assurances of the Association's success. The selection of a member of the Interstate Commerce Commission can hardly fail to have a marked effect in allaying public distrust and enmity toward the new plan for maintaining rates; and there will be much less liability of jealousies arising among members of the Association than would be the case if its chief officer had any previous ties which might cause any of the members to suspect him of partiality. The owners of the securities of Western railways are looking very anxiously for the success of the plans for maintaining revenue into which the heads of their companies seem to have entered so heartily; and it is to be hoped that the harmony and willingness to co-operate thus far shown may continue.

A "subscriber since 1875" writes us making two complaints, or rather suggestions, which it will perhaps interest other readers likewise to note. He says:

I do not want to complain loudly of a journal that I have found better and better every year, but there is a certain specific complaint that I want to make in regard to the 'make up.' 1. You formerly had a Table of Contents on the inside at the beginning of the reading matter. You removed it to the *outside* of the journal, where, of course, it is valuable, but it was a great convenience upon the inside, especially when the advertising pages are abandoned in binding. 2. The manner of making up the pages compels one when he binds to load up the volume with a vast amount of contracting and construction notes, which lose their value after a few weeks.

A brief answer to the first "complaint" is that the weekly index was removed to the outside of the paper at the suggestion of several readers on what we regard as the very sound ground that while the paper is unbound that is the most convenient place to consult an index and after it is bound, the full general index saves all need for preserving or consulting it at all. A brief answer to the second "complaint" is that we have multitudes of subscribers by whom the weekly news departments are the most valued in the paper, and who are anxious to preserve them for subsequent reference. They have a permanent value *as history*, and we have ourselves constant occasion to refer to them, as do multitudes of others. The journals which scatter such matter through their advertising pages do not do it by any means for the sake of their readers, but as an extra inducement to advertisers to bring their cards "in with reading matter,"—an inducement we do not deem i expedient to offer.

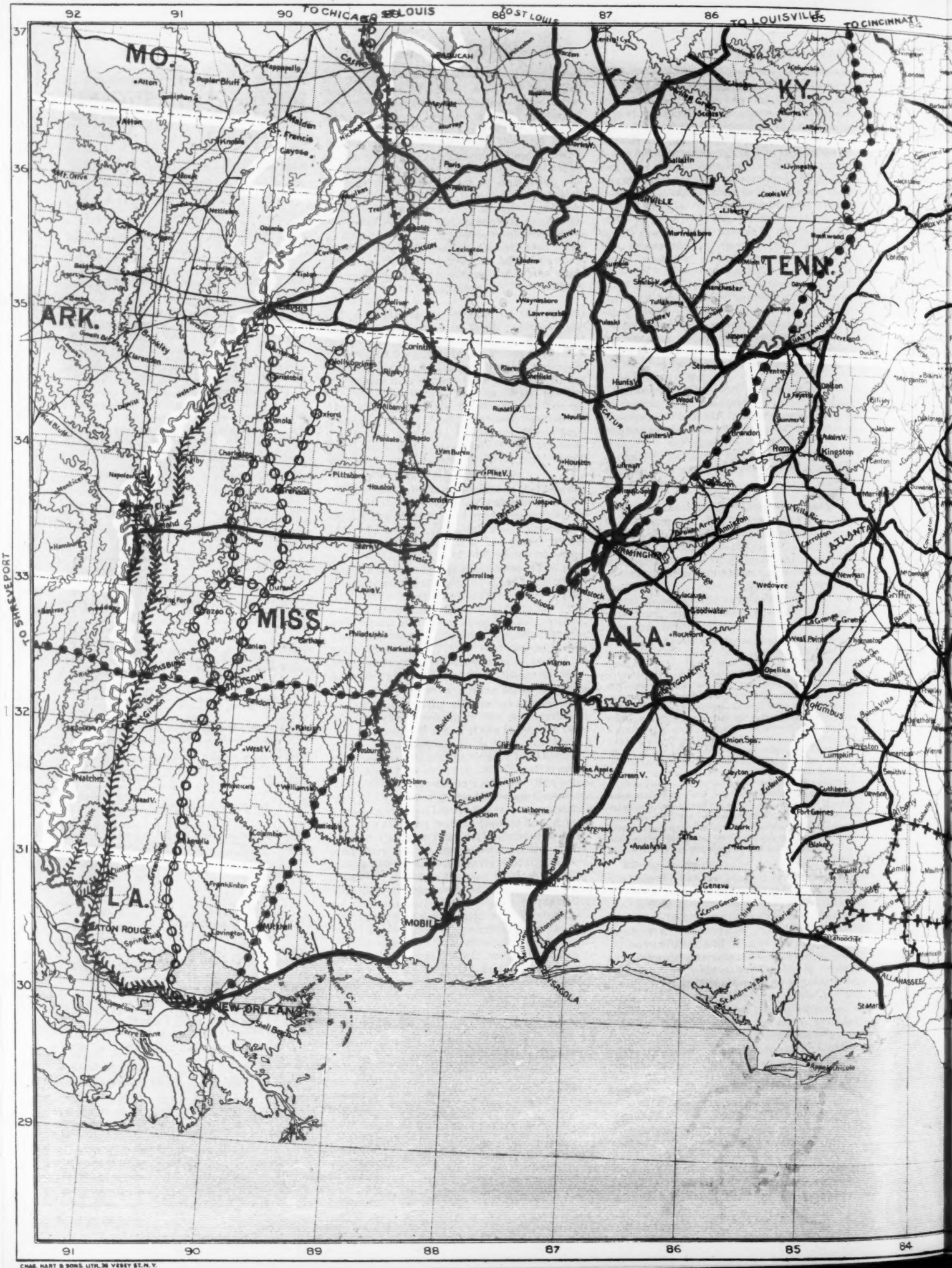
There is nothing more welcome to the careful editor than suggestions from friendly readers as to how the form or substance of his journal can be improved. As we take this occasion to say again, we always feel under obligation for them; but no one but an editor realizes how many different tastes and needs are to be consulted.

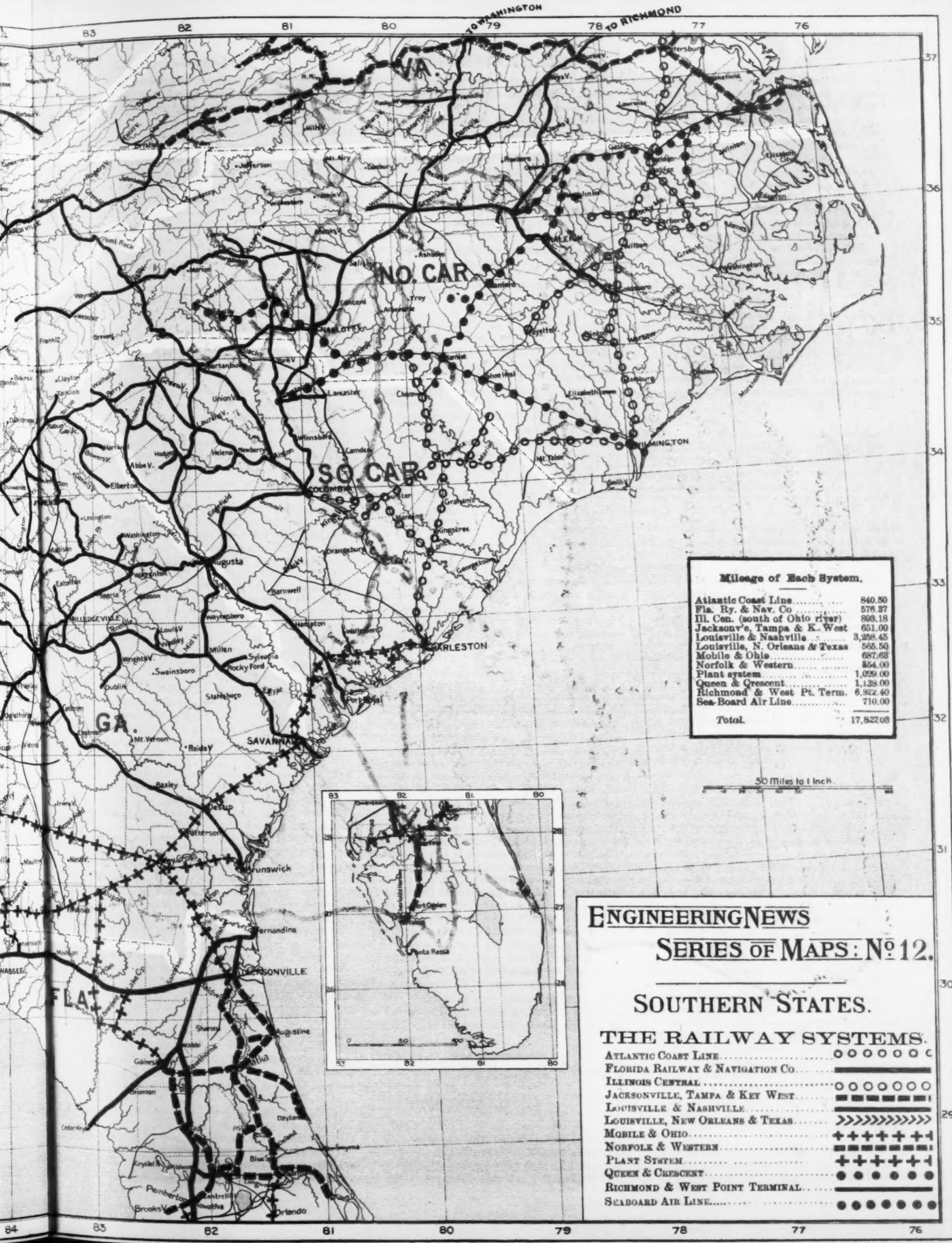
MR. ANDERSON of Kansas offered a resolution in Congress a few days ago in reference to the proceedings at the recent meeting of Railway Presidents in this city. The resolution begins by quoting the recent statements of CHARLES FRANCIS ADAMS in reference to the "covetousness, want of good faith, and low moral tone" of railway managers. It then continues, with the most horribly bad grammar and rhetoric:

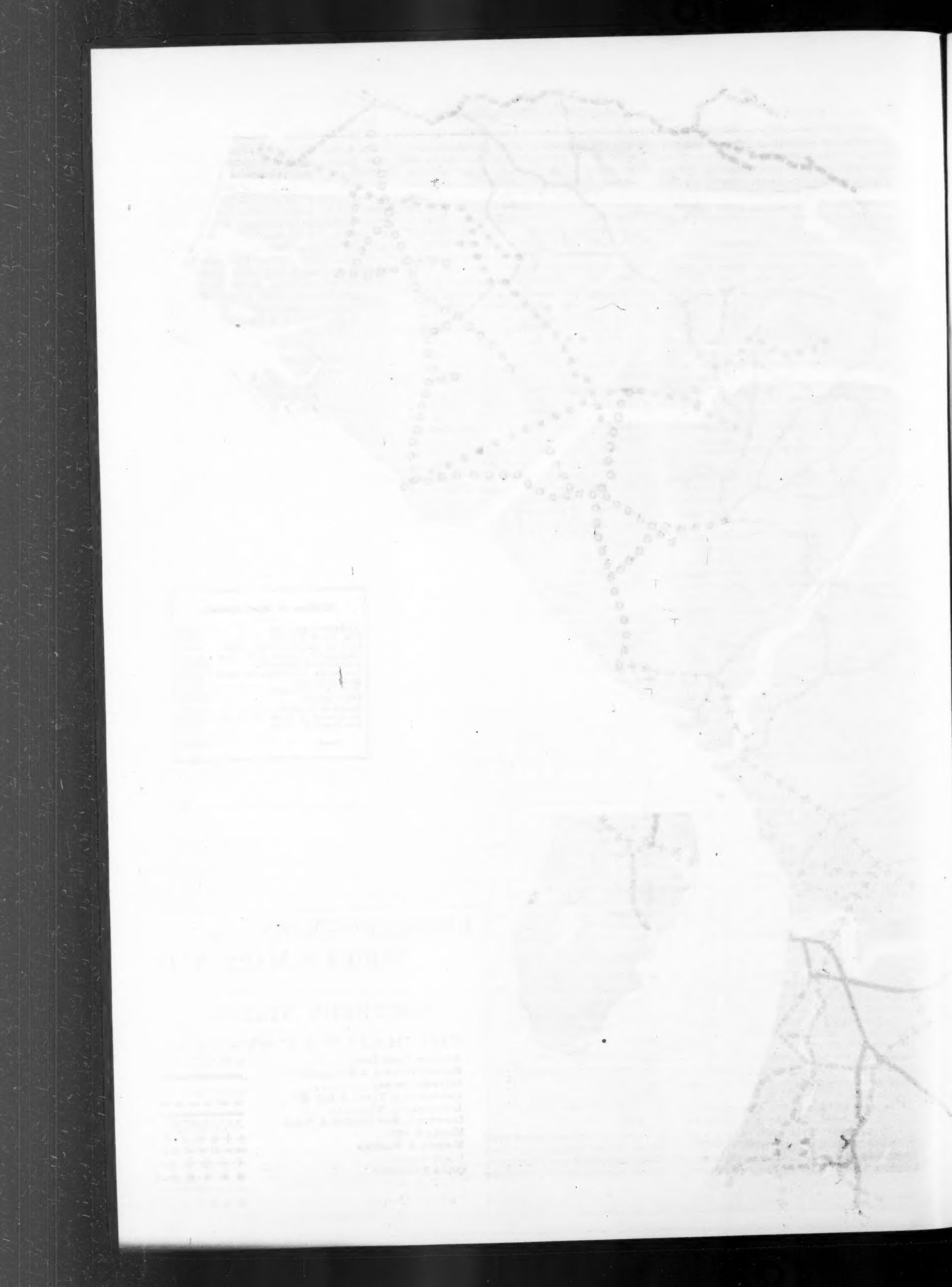
Whereas, At said meeting, inspired and dominated by said officers of the confessedly law-breaking companies, chiefly "of the region west of Chicago," with the conspicuously avowed purpose of maturing plans for the enforcement of said act and protecting these great and powerful corporations from wreck at the hands of subordinates, it seems that the real object, if its proceedings were correctly reported through the daily press, was to perfect a plan, which, under cover of the avowed purpose, means a deliberate, sweeping violation of the spirit, if not of the letter, of the most important provisions of said Act; as by the terms of the agreement reached. As reported, one officer of each company may be held responsible for the strict maintenance of rates and rules established by the association which was created at said meeting, thus taking into their own hands the practical revision of the act, in harmony with the suggestion of Mr. ADAMS, in this way giving direct application to his declaration that "the railroad system must heal itself; no act of Congress, nor the repeal of any act of Congress, will greatly help it."

The next paragraph recites Mr. ADAMS' statement that the plan of organization was approved by members of the Interstate Commerce Commission. It is then stated that the manifest intention of the Interstate law is to prohibit any agreement whatever in restraint of competition, and that as the law requires copies of all contracts to be filed with the commission, that body is notified to report within 10 days all information it may possess concerning the action of the Presidents' meeting; to state to what extent the members of the Commission took part in discussing, criticising and approving the plans for maintaining rates adopted by the Association; and to give the Commission's opinion as to the legality of the said plan together with a report as to "what legislation is necessary to prohibit the form of contract, agreement, or combination for the prevention of competition, which was submitted at the New York meeting, if the same be not already probibited by existing law."

WHETHER this resolution will be adopted remains to be seen. It certainly ought not to be adopted without amendment, for as origin-


TO CHICAGO & ST LOUIS
TO ST LOUIS
TO LOUISVILLE
TO CINCINNATI
MO.
KY.
TENN.
ARK.
MISS
ALA.
L.A.
TO SHREVEPORT
MEMPHIS
VICKSBURG
JACKSON
MERIDIAN
BIRMINGHAM
MONTGOMERY
ATLANTA
MOBILE
NEW ORLEANS
BATON ROUGE
PENSACOLA
TALLAHASSEE
CHAS. HART & SONS, LITH. 38 VESEY ST. N.Y.


TO WASHINGTON
TO RICHMOND
VA.
NO. CAR.
SO. CAR.
GA.
FLA.
COLUMBIA
CHARLESTON
SAVANNAH
JACKSONVILLE
WILMINGTON
RALEIGH
Augusta
Orlando
Mileage of Each System.
Atlantic Coast Line 840.50
Fla. Ry. & Nav. Co 576.37
Ill. Cen. (south of Ohio river) 893.18
Jacksonv'e, Tampa & K. West 651.00
Louisville & Nashville 3,258.45
Louisville, N. Orleans & Texas 565.50
Mobile & Ohio 687.63
Norfolk & Western 454.00
Plant system 1,029.00
Queen & Crescent 1,139.00
Richmond & West Pt. Term. 6,922.40
Sea-Board Air Line 710.00
Total. 17,827.08
50 Miles to 1 Inch.
ENGINEERING NEWS
SERIES OF MAPS: No. 12.
SOUTHERN STATES.
THE RAILWAY SYSTEMS.
Atlantic Coast Line
Florida Railway & Navigation Co.
Illinois Central
Jacksonville, Tampa & Key West
Louisville & Nashville
Louisville, New Orleans & Texas
Mobile & Ohio
Norfolk & Western
Plant System
Queen & Crescent
Richmond & West Point Terminal
Seaboard Air Line



ally worded its implications are false and misleading. Simply because a few prominent men have lately been railing against railway traffic managers as persons devoid of moral principle, it certainly is not proven that all railway men are desperately wicked nor that the corporations themselves are violating the law, as this resolution declares.

Certainly if, as Mr. ANDERSON states, the intent of the makers of the Interstate law was to prohibit all agreements between railway companies in restraint of competion, the law does not express that intent. The clause in reference to this prohibits only "pooling of freights of different and competing roads."

It will therefore become the duty of the Interstate Commission, if this resolution passes, to inform Mr. ANDERSON and his colleagues in the first place that the agreement on which the Interstate Railway Association is based is not contrary to law.

To comply with the second requirement of this resolution and inform Congress what legislation is needed to prohibit such agreements as that adopted at the recent Presidents' meeting, gives the Commission an opportunity which it is to be hoped will be improved. They must face an unenlightened public opinion, of which Mr. ANDERSON is a fair representative, which clamors for the prohibition of all contracts to restrict competition in railway traffic.

The Commission has just given its informal approval to such a contract, involving one-third the railway mileage of the country, and it is now asked to inform Congress what legislation is needed to render this and similar contracts illegal. There is but one course open to Judge COOLEY and his colleagues. They understand as well as any one the widespread ruin which such legislation would effect if it were enforced. It is their duty to explain this fact in the briefest and plainest manner possible. It is their duty to show to Congress that contracts to restrict competition are an absolute necessity to the solvent existence of our railways; and that in the power of the State to regulate both traffic rates and facilities there is ample protection for the public against any abuse of this privilege by the railway companies.

APROPOS of brass tapes, we have received from Messrs. YOUNG & SONS a sample piece of their steel chain tape referred to in the letter which appeared last week, which we have "tested to destruction" at many points, and which certainly seems to be a most excellent tool. Having the straight temper, it is difficult to kink it, much more difficult than to kink a brass tape. On the other hand, when it is kinked it is far easier to break it off than it is a brass tape, for it is almost impossible to break the latter by however rough usage, kinked or not kinked. The steel tape is narrower and thicker than brass tapes used to be, and will probably sag more, as it is heavier; but for measuring long distances we should give the steel tape a decided preference over either a steel chain or a brass tape. For city surveying work, or any other kind requiring frequent accurate measurement of irregular distances, we should prefer the brass tape, however, decidedly. We are surprised that we have not yet heard from any of our Boston subscribers as to the extent to which the brass tape is now used there, but shall hope to do so in time.

It appears to us that the steel chain tape could be improved, first by numbering each foot on the riveted brass collar which marks it, on which numbers could easily be stamped by slightly enlarging them, and secondly by adding a "minus foot" to which a brass strip graduated to hundredths was attached, making the entire tape 101 ft. long but measuring from the end of the "minus foot" for chain measurements. This would be just as easy to do, and would greatly widen the useful range of the "steel chain tape," making it needless to use the ordinary steel tape for fine measurements, which is a much more fragile affair. For all ordinary railroad work, and especially all construction work, we should greatly prefer these tapes to a chain.

The Railway Systems of the Southern States.

The States lying south of the Ohio and east of the Mississippi river contain 12 important railway systems, whose rapid growth has been one of the prominent features of the past decade. To show the territory covered by each of these systems, and their respective location, we present to our readers with this issue Map No. 12 of our series, on which the lines of each system are shown each designated by an especial symbol or color.

In the following table is shown the existing railway mileage of the Southern States (including the Virginias and Carolinas, Georgia, Florida, Alabama, Mississippi, Kentucky and Tennessee) by half decades for the past 50 years. The figures are taken from the U. S. Census reports and Poor's Manual.

Year	Total Mileage on Jan. 1.	Year	Total Mileage on Jan. 1.
1839	425	1864	8,644
1844	1,258	1869	9,495
1849	1,585	1874	13,126
1854	3,102	1879	14,192
1859	6,170	1884	18,591
		1889	25,256

By this table it appears that 44 per cent. of the existing mileage of the above States has been built within the last 10 years. The score of years between 1859 and 1879, during which 5 years of war and the 4 years of extreme financial depression following the panic of '73 caused a sharp check in construction, showed a total increase of mileage less by 3,000 miles than the record for the past 10 years.

But not only is a large proportion of the total mileage of these States due to enterprises of the present decade, the railway systems of the South have grown up almost entirely within the past 10 years. The fact that no longer ago than 1880 the railways of the South were only remotely connected with the other railways of the country is well illustrated by the fact that, at that date, of the 15,605 miles of track then in use in these States, 12,137 miles were 5-ft. gauge, and only 1,410 miles were standard width. At the same time, but 23 per cent of the total track was laid with steel rails, while in the Middle States 42 per cent. of all the track was steel. But during the present decade the Southern railways have more than ever before attracted the attention of Northern and foreign capitalists. These men have furnished the funds for the rapid extension and permanent improvement of the roads, and have welded together the scattered local lines into large systems.

RICHMOND & WEST POINT TERMINAL.

The mileage of this extraordinary system, the greatest in the South by far, and exceeded by only one or two in the world, is now as follows:

Richmond & Danville system	858
Virginia Midland Ry	413
Charlotte, Columbia & Augusta, Columbia & Greenville, and Western North Carolina Rys.	959
Georgia Pacific Ry	516
East Tenn., Va. & Ga. system	1,823
Central Railroad of Georgia system	2,256
Other railways owned or controlled	317
Total	6,922

This company was formed in 1880, in the interest of the Richmond & Danville Railway Company, to acquire control of railways not directly connected with the Richmond & Danville; and it has accomplished its purpose most thoroughly. The bond by which the different roads of the system are bound together is different from that uniting the component parts of any other great system; and the relation of the Richmond & West Point Terminal Company to some of the roads under its control is exceedingly complex. For example: The Wrightsville & Tennille Railroad in Georgia forms a part of the Central R. R. of Georgia system because that company owns its bonds and preferred stock. But a controlling interest in the stock of the Central R. R. of Georgia Co. is owned by the "Georgia Co." and the stock of the "Georgia Co." is owned by the Richmond & West Point Terminal Co.

It will be seen from the above that a "Terminal" stockholder who should wish to know what portion of the Wrightsville & Tennille road he really owned, would have a rather complicated problem to solve. Whether such complexity in corporate affairs is commendable, may certainly be questioned; but to discuss that question here is apart from the scope of this article.

The northern terminus of the Richmond Terminal system is at Washington, D. C., and the main line extends thence southwest *via* Lynchburg, Danville, Charlotte, Atlanta and Birmingham to a terminus on the Mississippi river at Greenville, Miss., a total distance of 1,113 miles.

The line from Atlanta to the Mississippi river is the Georgia Pacific division. Part of the line across Mississippi is still under construction; but it is now so near completion that it is included on the map and in the figures of mileage. The East Tennessee, Virginia & Georgia division also reaches the Mississippi at Memphis by means of the Memphis & Charleston. At this point connection is made by a ferry transfer with GOULD'S Missouri Pacific system; and it is probable that as soon as the through line to Greenville is open for traffic, steps will be taken to obtain connection at that point with the branch of the Missouri Pacific terminating at Arkansas City, Ark. It is indeed believed by many that an alliance between the Richmond & West Point Terminal and the Missouri Pacific systems is among the probabilities of the near future.

The Richmond Terminal lines now reach the sea-coast at five points, Mobile, Ala., Brunswick and Savannah, Ga., Port Royal, S. C., and West Point, Va. A sixth terminus at Norfolk, Va., will be in use in a few months, and will be reached over the Chowan & Southern extension, now under construction. In the seven States in which the system lies, almost every important city is reached. While the main lines of the system are admirably located for furnishing direct connection between the chief commercial centers of the South, the local feeders and branch lines are almost all in that productive belt lying between the mountain region and the low lands along the coast. There are now quite a number of feeders, however, in the mineral districts of Alabama and Tennessee, and more are likely to be built or acquired as fast as the prospects of traffic will warrant. Among the managers of the company are some of the best business men of the South, and they plan to develop the traffic of their system by the establishment of a bureau for promoting and aiding new manufacturing and mining industries by the loan of capital and by building sidings or branches to furnish traffic facilities when needed.

There is a considerable element in the South in favor of the dissolution of the system by judicial or legislative action. Some progress

in this direction has already been made; the lease of the East Tenn., Va. & Ga., system was annulled by the court, and the present control through the ownership of preferred stock will expire in 1891. It is not likely, however, that the movement to this end will be permanently successful, and the managers of the system are likely to go on with their work of consolidation as fast as the state of public opinion will warrant.

There are certain indications that the Atlantic Coast Line system is favorably regarded by the Richmond Terminal managers, and that its acquisition will be the next important Southern deal to be announced.

This remarkable system comes the nearest of any on the continent to covering a great area completely and non-competitively.

LOUISVILLE & NASHVILLE.

The mileage of this system is now as follows:

Operated by Louisville & Nashville Co.	1,258.08
Controlled by owne ship of majority of capital stock:	
Nashville, Chattanooga & St. Louis system.	650.21
Other lines.	350.16
Total	3,258.45

The Louisville & Nashville system is probably entitled to rank as the oldest in the South. Ten years ago it controlled 975 miles of railway, and its growth has been steady since the completion of the original line from Louisville to Nashville, 30 years ago. The system extends from northern termini at St. Louis, Mo., and Cincinnati, O., to New Orleans, La., 921 miles from Cincinnati and 944 miles from St. Louis. A branch runs southwest to Memphis, and an extensive system of branches is operated in Kentucky, north of the limits of our map. The main line passes through Louisville, Nashville, Birmingham and Mobile.

The Nashville, Chattanooga & St. Louis system is owned and operated by a separate company, but the majority of its stock is held by the Louisville & Nashville, and it is therefore properly included as part of that system. Its lines extend from a Mississippi river terminus at Hickman, Ky., east *via* Nashville to Chattanooga, Tenn., 319 miles, and there are over 300 miles of branches, chiefly built to develop mineral regions in eastern Tennessee.

Besides the mileage in the above table, the "L. & N." has a joint lease of the "Georgia Railroad & Banking Company's system" in Georgia and Alabama, 729 miles in extent. This mileage is, however, a part of the Richmond & West Point Terminal rather than of this system, and we have so represented it upon our map.

The most important feature in connection with the present and future growth of traffic on the Louisville & Nashville lines is the development of the mineral resources of the South. The principal extensions recently built and now projected have this for their object, and are already furnishing much of the system with a far heavier traffic than that which it enjoyed a few years ago. While the agricultural interests of the South are susceptible of much development, its staple products are of small bulk compared with the corn and wheat crops of the West; and no such close network of lines as cover the prairie States could be supported in the agricultural regions of the South. But its mountain section is destined to be one of the chief mining districts of the country, and the Louisville & Nashville more than any other company is taking the lead in their development. Besides the branches of the Nashville, Chattanooga & St. Louis, already referred to, the company now operates 122 miles in the vicinity of Birmingham, the Nashville, Florence & Sheffield Ry. to Florence, Ala., and a line in eastern Kentucky, which is being extended to Cumberland Gap, to meet the Norfolk & Western extension. Since 1882 the company has paid no dividends to its stockholders except a scrip dividend last year. It is confidently believed, however, that the growth in its traffic above noted will soon increase its income sufficiently to enable cash dividends to be resumed.

The remaining ten systems of the South are much smaller than the two already described. Six of them lie chiefly between the Atlantic coast and the Richmond Terminal system, and the four others, in the Mississippi Valley. We will consider the Atlantic systems in geographical order, beginning at the north.

NORFOLK & WESTERN.

The main line of this system extends from Norfolk, Va., west to Bristol, Tenn., 408 miles. Branches and extensions in the western part of Virginia increase the total mileage to 554 miles. These lines were built principally to develop coal lands, and the shipments of coal and coke over the system have increased from 105,805 tons in 1883 to 1,308,594 tons in 1887; of this 741,875 tons were carried to tide-water at Norfolk. Iron ore traffic is also rapidly developing, the shipments in 1887 being 128,696 tons, an increase of 95 per cent. over the preceding year. The further development of the mineral resources of this section is being pushed, and many coke ovens and iron and zinc furnaces are being erected. The last annual report of the company states that within 6 years, although the mileage operated increased but 24 per cent., the passenger traffic increased 159 per cent., and the freight traffic 310 per cent. The Clinch Valley extension, now under construction, will give the company a direct connection with the Louisville & Nashville system; will tap a mineral region which is, according to all accounts, of remarkable richness; and will furnish the shortest route to the sea-coast for the several important roads which are now building to reach Cumberland Gap. The report of the company's operations for 1888, received since this paragraph was in type, shows an increase over 1887 of 23 per cent in passenger and 13 per cent. in freight traffic.

It has been said that the company's failure to secure the desired lease of the East Tennessee, Virginia & Georgia system from the Richmond & West Point Terminal Co. was a great blow to its future, but an examination of our map hardly substantiates this. The company now controls the only outlet to tide-water from the rich mineral region which it is developing, and this must furnish its chief traffic in any case. Unless the Richmond Terminal managers obtain control of the new road now building from Norfolk to Danville and push it on west to Bristol, the Norfolk & Western must still be the chief outlet of the northern part of the East Tennessee, Virginia & Georgia system, by virtue of its location.

SEA-BOARD AIR LINE.

This system consists of the railways owned and controlled by the Sea-board & Roanoke R. R. Co., extending from Norfolk, Va., southwest *via* Raleigh, N. C., to Hamlet, N. C. From here the Carolina Central R. R. runs east to Wilmington and to Rutherfordton, N. C. The Georgia, Carolina & Northern Railway is projected to extend from Monroe, N. C., to Atlanta, Ga., and has been completed the past year to Chester, S. C., 45 miles. If the line is completed to Atlanta, the system will assume considerable importance as a competitor for the through traffic between that center and northern points. The total extent of the system is 710 miles. In connection with its railway lines, the company operates a steamer line between Norfolk and Baltimore.

ATLANTIC COAST LINE.

This system has an extent of 840 miles. Its northern terminus is at Richmond, Va., and its southern at Charleston, S. C.; it reaches also Wilmington, Weldon and Fayetteville in North Carolina and Columbia in South Carolina. The controlling company of the system is the Wilmington & Weldon. Practically all the mileage of the system is in the low-lying lands of the South, and the local traffic of the system is not heavy. The importance of the system as a competitive line is from the advantage it offers as the direct route between the Northern sea-board cities and the Florida winter resorts. The company has joined with the Richmond & West Point Terminal to build a line to Norfolk, Va., and the work is now far advanced. The report that the system is likely to become a part of the Richmond Terminal at an early date has been already referred to. Through an auxiliary company, the Manchester & Augusta, some work is being done on an extension to Augusta, Ga.; but at the present rate of progress, it will be a good while before it is completed.

PLANT SYSTEM.

The bond of union between the different companies whose lines compose this system consists in the fact that a controlling interest in the securities of the several companies is held by the Plant Investment Co. of this city. The companies controlled are the Savannah, Florida & Western, Charleston & Savannah, Brunswick & Western and South Florida, and the total extent of the system is 1,029 miles. The main line from Charleston, S. C., to Jacksonville, Fla., forms the southern division of the direct route to Florida before mentioned.

Other points reached are Albany, Bainbridge and Thomasville, Ga., and Monticello and Gainesville, Fla. The South Florida Ry. lies in the southern part of that State, disconnected from the rest of the system. It extends from Sanford to Tampa, with a branch to Pemberton. Like the preceding, the Plant system is wholly in the low-lying and sparsely populated portion of the South, and except for a considerable lumber business, the local traffic is light. Besides its railways, the Plant company operates steamer lines on the St. John's and Chattahoochee rivers and an ocean line from Tampa to Havana.

FLORIDA RAILWAY & NAVIGATION CO.

This system consists of a line from Jacksonville, Fla., west to River Junction, and a line from Fernandina south to Plant City, with branches to Cedar Key and Orlando, a total of 576 miles, all within the State of Florida. The system has been in the hands of a receiver since November, 1885. A plan of reorganization has been adopted, however, and is now being carried out. The company when reorganized will be known as the Florida Central & Peninsular Ry. Co.

JACKSONVILLE, TAMPA & KEY WEST.

The lines of this system, like the preceding, are entirely within the State of Florida. Its total extent is 651 miles, and with the exception of the line from Bartow to Punta Gorda and the new Jupiter & Lake Worth line, the roads are located in the central part of the State and reach the principal points frequented by winter tourists from the North, St. Augustine, Palatka, Sanford, and others. The acquisition of the lines of the Florida Southern Ry. by the company is a recent move, and makes the system the chief one of the State. Besides its railway lines, the company runs a line of steamers on the Indian river from Tomoka to Jupiter, 250 miles.

QUEEN & CRESCENT.

This is a common title for the system of

railways more formally known as the "Cincinnati, New Orleans & Texas Pacific Ry. and associate roads." The system comprises the following railways:

Cincinnati Southern	335.9
Alabama Great Southern	295.5
New Orleans & Northeastern	195.5
Vicksburg & Meridian	141.8
Vicksburg, Shreveport & Pacific	170.4
Total	1,139.1

The system extends from Cincinnati, O., south *via* Lexington, Ky., Chattanooga, Tenn., Birmingham, Ala., and Meridian, Miss., to New Orleans, with a branch from Meridian west to Shreveport, La. The Cincinnati Southern division of this system is peculiar in being one of the few important railroads built directly by a city to benefit its trade. The control of the various roads composing the system is held by an English corporation, which helps to explain why the company controls so long a line with absolutely no branches or feeders under its own control. In this respect it is, so far as we recall, without a parallel among American systems of its size and importance.

MOBILE & OHIO.

The main line of this system extends from Mobile, Ala., to St. Louis, Mo., a distance of 644 miles. A few short branches bring up the system's total extent to 687.6 miles. The cities along the line are almost all of minor importance, and as a consequence the traffic of the road has never been heavy. The road has some quite heavy grades which handicap it in carrying through traffic. The company owns a land grant of over 1,000,000 acres, and it is now endeavoring to develop this and the local territory tributary to the line as a means of increasing its revenues. Its managers are well aware of the desirability of building branch lines to secure an increased revenue, but the financial status of the company has forbidden this, and the building of new competing lines by other companies has had a tendency to cut down traffic rates and income. The managers of the company are endeavoring to build up the foreign commerce of Mobile, and believe that as the improvements which the Government is now making to that harbor are completed, the facilities offered will greatly increase the business of the port.

ILLINOIS CENTRAL.

While the greater portion of the mileage controlled by this company is located in the Northwest, the extent and importance of the mileage which it controls south of the Ohio river entitle it to consideration with the other Southern systems. The main line of the system extends from Chicago to New Orleans, 915 miles, *via* Cairo, Ill., Jackson, Tenn., and Grenada, Miss. There are three branches from the main line in Mississippi, reaching to Aberdeen, Greenwood and Memphis, Tenn. The total mileage south of the Ohio river is 863 miles. The company has made surveys for a line from Cairo to Memphis along the Mississippi, which would give it an entrance to Memphis from the north, and would probably be used as the main line. Its system of branches in Mississippi is not likely to be greatly extended, at least until the policy of that State toward the railway companies operating within its borders is somewhat more liberal.

LOUISVILLE, NEW ORLEANS & TEXAS.

The main line of this system extends from Memphis to New Orleans, 455 miles, and 110 miles of branches are now in operation. The main line runs *via* Vicksburg and Baton Rouge, following the general course of the Mississippi river for the whole distance. The main line forms a connecting link in what is commonly known as the HUNTINGTON system of roads, joining the Chesapeake, Ohio & Southwestern road on the north and the Southern Pacific at the south. The branches are short local lines in the rich agricultural district back of the Mississippi levees. The Huntington branch runs to a point opposite Arkansas City, and connects by a ferry transfer with the branch of the Missouri Pacific system terminating at that point.

The total mileage included in the above systems is 17,827 miles. Of this 369 miles are in Illinois and 508 miles in Louisiana, leaving 16,950 miles controlled by the 12 systems in the States lying south of Ohio and east of the Mississippi rivers.

Let us now add to this the mileage of the systems belonging to other sections of the country but having some lines within the borders of these States. The Kansas City, Ft. Scott & Memphis, a Southwestern system, controls a railway from Memphis, Tenn., to Birmingham, Ala., with two short branches, a total of 274 miles. In Virginia, West Virginia & Kentucky, north of the limits of our map, the Baltimore & Ohio and the Chesapeake & Ohio, two of the trunk line systems, have 1,529 miles of railways. The Pennsylvania system also has 30 miles in Virginia, and the lines controlled by the Newport News & Mississippi Valley and the Kentucky Central companies are probably more properly classed as systems than as independent lines. These two companies control 697 miles of lines in the State of Kentucky. Add now the total mileage of these various lines to the mileage of the 12 systems within the States above named, and we have for the total mileage of Southern railways included in systems, 19,480 miles. As stated above, the total railway mileage of these States is now 25,256 miles, hence 77 per cent. of the total mileage is included in systems and but 23 per cent. are independent lines. By reference to our editorial in ENGINEERING NEWS of Nov. 24, it will be seen that this percentage is very close to that which we found for the New England and Canadian railways, of which 26 per cent. are independent lines; but it shows a slightly smaller proportion of independent lines in the South.

The Examination of Cast-Iron.

The problem which consists in estimating the quality of cast-iron is not, remarks *Le Charbon*, of the same importance in all foundries. In many small foundries only one quality of iron has been required for years, and the proportions are sufficiently well known to make it easy to dispense with the examination of the cast-iron. It is not so, however, in large iron foundries, which use directly the products of the blast furnaces. This direct method was formerly the only one employed, and it is still adopted wherever the blast furnace is heated with charcoal. Small blast furnaces heated with charcoal are greatly affected in their working by accidental irregularities resulting from the mixture, the charging, the dampness of the materials which have been introduced, the temperature of the current of air, etc., and the most experienced founder is not always sure of obtaining a casting of invariable quality. It follows that it is necessary to examine the cast-iron, often several times a day, to see if it is suitable for the purpose for which it is intended. This method is simple and sure.

The quality is determined according to the agitation of the crude iron. This test is carried out every morning in the presence of the foreman. A mould is made with the hand in the sand of the hearth in front of the blast furnace, having the form of a cylindrical hole 20 centimetres in diameter and 7 or 8 centimetres deep. The iron is run from a casting ladle into this mould after the impurities have been removed from the surface of the bath.

The color simply of the iron contained in the ladle enables them to estimate in a summary manner the quality of the iron cast. If the color is white, and the surface of the metal is covered with a layer of gas burning with a colorless flame, the casting is considered to be satisfactory. If the metal presents a reddish appearance and gives place to the formation of crackling sparks, they are not very well satisfied with it. They then pour the metal into the sand-mould and remove afresh the matter which covers the surface of the bath. Then the agitation of the iron commences. If the pig is rich in silicium and carbon, the iron being burnt, the surface of the bath is soon covered with a crust of oxidized formation, giving forth a pale light. This crust is broken from time to time by the rising of the metal below.

Such an iron contains much graphite, and founders do not care a great deal for it. The kind of iron most suitable for being cast, even in small moulds, and which does not give place to the formation of scum, presents, immediately after being poured out, a very great degree of mobility and of some duration. But when the agitation is very short, and if brownish spots form on the surface (which has been the subject of so much discussion in metallurgical literature) accompanied by sparks in large quantities, the metal is poor in silicium, is hard, easily becomes white, and is only suitable for large castings.

The characteristic signs manifested by the agitation of the metal are nearly always the same in most foundries, but there are others which vary with the kind of blast furnace. In cupola furnaces, when the re-casting of raw iron used in commerce is carried on, the agitation of the metal is not of a nature such as to give sufficient indications of the quality of the raw iron and of the value of the mixtures which have been introduced into the blast furnace. In such cases other methods of investigation have to be followed.

In certain large foundries resisting tests are tried with the material worked. This method is much to be recommended. In this case the bars which have been cast are submitted to the test of bending, and for this purpose more or less complicated machines are used. It must not be lost sight of that raw iron of large grain, which is added during the casting to iron not possessing much silicium and graphite, has not the same resisting qualities as when iron of fine grain has been added.

Further, it is to be observed that the resistance to fracture alone is not sufficient to determine the suitability of a metal: it is also necessary to take into account the flexibility of the bar which is being thus tested. With iron which contains a large quantity of phosphorus, there is often experienced a somewhat high breaking resistance; but it breaks suddenly, without having been previously subjected to a high degree of flexion. In casting a column of a similar quality of metal, there is risk of its breaking when subjected to rough shaking. Even a water-pipe made of this metal may break under the shock of the water, after having resisted tests with double or triple the force of this shock. A furnace-plate may also break if it is heated on one side only.

The Proposed Water Storage for Rochester, N. Y.

A committee of the Rochester Chamber of Commerce was some time ago appointed to consider the subject of water storage for power and general consumption. The members of this committee, Messrs. ROSS, HAMILTON, LINDSAY and GILLIS, have now handed in their report under date of Jan. 7, and the following is an abstract:

The committee upon entering upon their work had before them the careful report of Mr. MCCLINTOCK, who recommended the building of a dam about 114 ft. high across the Genesee river in the gorge above Mount Morris. The committee had further examinations made by the well-known hydraulic engineers, Mr. JAMES B. FRANCIS, CLEMENS HERSCHEL and J. T. FANNING, and also by State Engineer JOHN BOGART. As the result of these investigations, they report that the dam proposed is entirely practicable and can be built with absolute safety. The gorge selected is naturally adapted to the work of creating a reservoir with a capacity of about 8,000 million cubic feet. The banks are from 300 to 500 ft. high and the stream varies in width from 900 ft. to three-fourths of a mile. The dam would be about 900 ft. long.

The drainage area of the Genesee Valley is 2,474 sq. miles, and the topography is such that destructive floods take place in the upper valley. This dam

would regulate the flow from all this upper valley, a flow which at Mount Morris varies from 100 to 34,000 cu. ft. per second. With this water under control and used in connection with the magnificent fall in the city, it would give an aggregate head of 236 ft. and a continuous water-power estimated at 30,000 H. P.

The immediate and more important result of such a dam would be to create 1,000 H. P. permanent, at Mount Morris, and secure the flats below that point from over-flow; to create at Geneseo 500 H. P. permanent, and 600 more at York Landing; to secure an additional necessary water-supply to the Erie Canal as far east as the Seneca river; and to insure the State and city against flood damage, improve the sewerage discharge, etc.

The committee recommend a combination of State, city and water-right owners in carrying out this scheme, as the plan least objectionable and most just to all concerned; and they futher recommend that the State appropriate $5,000 to be expended by the State Engineer in rainfall and evaporation investigations, definite survey of the site of the reservoir and dam, etc. The committee was continued and asked to draft a memorial to the Legislature asking for the $5,000 required.

The Newark Water Supply.

The Newark water supply, by the Lehigh Valley R. R. Co., was under consideration this week in the shape of a new and formal proposition from this latter company. Briefly stated, the railroad company proposes to furnish water from the Pequannock, Wynockie or Ramapo river; to deliver it with a gravity head to the city, without pumping, and to build a pipe line of best material, not more expensive than steel, and not less than 4 ft. in diam. The fourth proposition of the Aqueduct Board, viz.: to build and perpetually maintain all necessary dams and reservoirs at the point of intake, is not assented to by the company in that form. But it will construct these dams and reservoirs and maintain them for a reasonable term of years, until all question of their substantial construction and fitness is determined by use. It will agree to turn them over to the city in perfect condition when the city acquires control, but thereafter the city must maintain them. As to terms of payment, the railroad company suggests the following, instead of the fifth somewhat indefinite condition made by the Aqueduct Board: That payment of $4,000,000 shall be made when the necessary works are constructed for the delivery of a supply of 25,000,000 galls., and if the city decide to take the 50,000,000 galls., the additional works shall be pushed on, and when completed in accordance with the contract, the city shall pay the additional $2,000,000. Pending the payment of the principal sums, payment for the water should be made quarterly instead of semi-annually, as suggested by the Board's fifth condition. The company will finally supply any required amount of water up to 50,000,000 galls. daily, and guarantee the same for any reasonable period of time, say 3 or 4 years. The acceptance of this proposition is not yet decided upon.

The Iron Output for 1888.

In the *Iron and Steel Bulletin* this week are published full details by State and districts of the production of pig iron in the United States in 1888, compared with the production of 1887. The total production in 1888 was 7,269,828 net tons, or 6,490,739 gross tons, against 7,187,206 net tons, or 6,417,148 gross tons in 1887. The production in 1888 was slightly in excess of 1887 and was the largest in our history. The extraordinary activity of the furnaces in the last few months of the year, notably in November and December, brought the total production far above the figures indicated by the statistical results of the first half of the year and by subsequent unofficial statements. While an increased production in the last half was anticipated, general surprise will be expressed upon learning how great it has been, which is shown as follows:

	Gross tons.
First half of 1888	3,020,092
Second half of 1888	3,470,647

The total production of pig iron in this country since 1881 has been as follows, in gross tons:

Year.	Gross tons.	Year.	Gross tons.
1881	4,144,254	1885	4,044,526
1882	4,623,323	1886	5,683,329
1883	4,595,510	1887	6,417,148
1884	4,097,868	1888	6,490,739

The production of pig iron in 1888, in net tons, classified according to the fuel used, was as follows, compared with the production of 1885, 1886 and 1887:

	1885.	1886.	1887.	1888.
Bituminous	2,675,635	3,806,174	4,270,635	4,745,110
Anthracite	1,454,390	2,099,590	2,338,389	1,925,729
Charcoal	399,844	449,557	578,182	598,789

The anthracite figures include all pig iron made with mixed anthracite and coke, as well as that made with anthracite alone. The production of pig iron with anthracite alone is now annually less than that with charcoal. If a tin-plate industry should be established in this country as the result of pending tariff legislation at Washington, our production of charcoal pig iron would doubtless largely increase. In an abundant supply of charcoal we would have a great advantage over Great Britain, which now makes scarcely any tin-plates from charcoal pig iron.

The production of pig iron in the Southern States in 1887 did not equal the general expectation, being only about 50,000 gross tons in excess of the production in 1886. But in 1888 the Southern pig iron industry made a great stride forward. The production in net tons was as follows, compared with the production in 1885, 1886 and 1887:

	1885.	1886.	1887.	1888.
Alabama	227,438	283,859	292 762	449,492
Tennessee	161,199	159,166	250,344	267,931
Virginia	163,782	156 250	175,715	197,396
West Virginia	69,067	98,618	82,311	95,259
Kentucky	37,553	54,844	41,907	56,790
Georgia	32,924	46,490	40,947	39,397
Maryland	17,299	30,502	37 427	17 600
Texas	1,813	3,259	4.383	6,587
North Carolina	1 790	2,209	3,640	2,400
Total	712,835	875.179	929,436	1,132,858

The increased production of pig iron in the Southern States in 1888 over 1887 was over 203,000 net tons. As late as 1865 the whole country made less pig iron than the South made in 1888.

Among the Northern and Western States which increased their production of pig iron in 1888 as compared with 1887 Pennsylvania is not to be counted, she made less in 1888 than in 1887; so did New York, New Jersey, Maryland, Wisconsin, and Missouri; Michigan's and Connecticut's figures for the two years do not materially vary. Illinois, Indiana and Massachusetts show slight gains in 1888. Ohio shows a great gain, jumping from 975,539 net tons in 1887 to 1,103,818 net tons in 1888, and nearly equaling the production of the whole South.

Notwithstanding the large production of pig iron in the last few months of 1888, there was no increase of unsold stocks beyond the quantity on hand at the close, of the first six months of the year; on the contrary there was a decrease. The stocks of pig iron which were unsold in the hands of manufacturers or their agents at the close of 1888, *and which were not intended for the consumption of the manufacturers*, amounted to 336,161 net tons, against 401,266 net tons on the 30th of June. The words which we have printed in italics should, however, have more than their usual weight this year, as it is entirely probable that some accumulations of Bessemer pig iron of which we have not taken account, and which are intended to be converted into rails, may be thrown upon the market if the demand for rails does not soon improve, precisely as was done with considerable quantities of Bessemer pig iron a little less than a year ago. In addition to the 336,161 net tons of unsold stocks in the hands of manufacturers at the close of 1888, there were also about 12,000 net tons of unsold pig iron in the hands of various other parties in Pennsylvania, Virginia, Alabama, Ohio and Missouri.

A 40-IN. TELESCOPE LENS is to be made by Mr. ALVAN G. CLARK for the University of Southern California. The telescope is to be mounted on Wilson's Peak when completed.

CORRESPONDENCE.

The Liverpool Vyrnwy Water-Works.

LIVERPOOL, Jan. 18, 1889

TO THE EDITOR OF ENGINEERING NEWS:

Permit me to correct an inadvertent but important mistake into which your correspondent has fallen in an article upon the Liverpool Water-Works, published in ENGINEERING NEWS of December 29, 1888.

In that article it is said that "the east end of the (Vyrnwy) dam is in solid rock; but the west end will be connected by puddled clay with the rocks beyond the masonry dam."

This would certainly mislead the reader. The fact is that both ends of the great dam are built upon and tied into the solid rock, to a height of 105 ft. above the lowest part of the foundation, while in the case of the northeast end, the rock connection extends to above the water level.

At the height of 105 ft., the southwest end of the masonry extends, for a horizontal distance of 165 ft., through a compact bed of water-tight clay, *against* which it is puddled. Then above this level of 105 (from the point 165 ft. into the heart of the natural clay) the impervious diaphragm is carried on by a puddle wall upon the rock in the natural clay. It will thus be seen that the puddle, without masonry, is only employed where the pressure is trifling, and in a natural clay formation, and is therefore not really part of the great dam.

I am, sir, your obedient servant,

GEORGE F. DEACON.

Some Steam Engine Conundrums.

POTTSVILLE, Pa., Jan. 22, 1889.

TO THE EDITOR OF ENGINEERING NEWS:—

I wish to ask the following questions.

1. Would there be any great advantage in a centerless engine, or, in other words, an engine that can be started backward or forward regardless of the position of the piston?

2. Would not an engine be more effective or powerful if steam could be used without exhaust resistance for the entire stroke?

3. Do not the slide valves, piston rings, crosshead guides, eccentric links, etc., of the present engines consume much power through friction?

4. Is it possible for an engine to be constructed without valves, eccentric rings, piston links, etc., to be effective? If such can be constructed, how would it be received?

Yours respectfully, E. A.

[1. For certain uses, yes; for others, no. The principal use for an engine, after all, is to run and not to start itself.

2. Exhaust resistance is bad, but causes no great percentage of loss. Anything which saves it without counterbalancing loss saves so much.

3. The machinery friction is from 10 to 20 per cent. of the indicated power according to size of engine. Very large and perfect engines run down to 5 or 6 per cent. when heavily loaded. Various oscillatory and rotary engines have been devised which much reduced the apparent sources of friction, but they have not commended themselves to very wide use.

4. All things are possible, but all things are not expedient. Doubtless there is still ample room to improve the steam engine, but the chance of any one man doing so is small. The ultimate test is work done per pound of steam *as shown by test*, not study of supposed advantages on drawings.—ED. ENG. NEWS.]

An Old Locomotive Test.

East Broad Top Railroad Co.,
Jan. 16, 1889.

TO THE EDITOR OF ENGINEERING NEWS:

In looking over some old plans and papers yesterday, I came across the enclosed clipping which I thought might be of sufficient interest to your readers to reprint.

I do not know what paper it was clipped from, but think it was the Philadelphia *Inquirer*.

I do not know the date, but perhaps the hieroglyphics at the foot of the advertisement on the back will tell you that. Respectfully yours, H. N. SIMES.

INTERESTING EXPERIMENT.—The President of the Philadelphia, Wilmington & Baltimore Railroad has for a year past been conducting an experiment with the Dimpfel coal-burning locomotive, for the purpose of ascertaining the difference in cost between coal and wood for fuel. The following is the result of the performance of the coal burner for one year, ending April 13, 1888: Number of miles run, 36,484; coal consumed, 4963½ tons, costing $2,309.30; wood for kindling, 58¾ cords, costing $207.66; water evaporated per pound of coal, 8 21-100 lbs. Cost of coal per mile run, 6 33-100 cts.; cost of wood for kindling, 57-100. The total cost of fuel per mile, 6 90 100 cts., being about one-half less than the cost of running wood burners. (The price of coal on this road is $5 per ton, and wood $3 85 per cord). The cost of repairs to the engine during the year amounted to $851.16, of which $377.96 was for materials, and $473.20 for labor. (This statement includes a new set of wheels, the others being defective when the engine was constructed.) The train run by this engine is the great express train, leaving Philadelphia at 1 o'clock P. M., and arriving back at 11.15 P. M., averaging from seven to eight long cars, and making quicker time than any train on the road.

[We reprint the cutting as above. The date of the paper is doubtless April 24, 1858, at which time, it appears, even the Philadelphia, Wilmington & Baltimore was burning wood, when coal would evaporate 8.21 lbs. of water per lb. of coal—a rate which it would make a good many locomotive superintendents happy to realize to-day.—ED. ENG. NEWS.]

The St. Clair Tunnel.

NEW YORK, Jan. 30, 1889.

TO THE EDITOR OF ENGINEERING NEWS:

In your notice last week of the proposed St. Clair tunnel, you mention that "the plan for the shield is not yet complete." This is an error, as the shields are on the ground nearly ready to be put together. It may be true, however, that the *plan* is not complete, as I fear that the

shield will not answer the purpose as at present designed and built. It is too weak to resist the pressure of the running clay and is unprovided with the bulkheads required in handling fluid or semi-fluid matter. It would answer well enough in the chalk of the British Channel; but I venture to predict that it will not build the St. Clair Tunnel, without radical change in plan.

Yours truly, C. L. KALMBACH.

The Peculiarities of the Figure 9.

Michigan Central Railroad Company.

DETROIT, Mich., Jan. 29, 1889.

TO THE EDITOR OF ENGINEERING NEWS:

The mathematical wonder quoted from the *Journal of Education* in your issue of Dec. 29 last can be somewhat illumined. The article says "another mathematical wonder is etc., etc."

The product of 9 8 7 6 5 4 3 2 1 by any number of two figures, except 10 or multiples thereof, will from the necessity of the case have the figures of the multiplier repeated as the first and last figures of the product; and when the multiplier is a multiple of 9 the figures intermediate between the first and the last one will in each case be the same, and will always be the difference between the first figure and 8. The reversals in the end figures shown in the cases given in the article referred to—of the multipliers 45—54 and 27—72—will be found to extend to the products obtained by the other pairs of the multiples of 9 whose sum equals 11 except the 1st and the 10th, e. g.,

45 is the 5th and 54 the 6th multiple of 9 $5+6=11$
27 " 3d " 72 " 8th " " $3+8=11$

So in the case of

—36 is the 4th and 63 the 7th multiple of 9 $4+7=11$
and 18 " 2d " 81 " 9th " " $2+9=11$

we have $9\,8\,7\,6\,5\,4\,3\,2\,1 \times 36 = 3$ nine fives and 6
" $\times 63 = 6$ " twos and 3
" $\times 18 = 1$ " sevens and 8
" $\times 81 = 8$ " zeros and 1

In extenso of the cases quoted, where 1 2 3 4, etc., is multiplied by 45 and 54, if we leave out the figure 8, and multiply 1 2 3 4 5 6 7 9 by the various multiples of 9, we have, using the 1st multiple —9 the product nine ones

2d	"	18	"	" twos
3d	"	27	"	" threes
4th	"	36	"	" fours
5th	"	45	"	" fives, etc.

All of which illustrate some of the many peculiarities of the figure 9.

Yours, X.

A Topography Slope-Board.

838 *East 170th St.*, NEW YORK CITY, Jan. 24, 1889.

TO THE EDITOR OF ENGINEERING NEWS:

In making topographical surveys I have tried several methods of obtaining the slope of the ground, keeping the records and plotting contour lines. I first used a hand level, a rod and a chain, to locate the positions of contours.

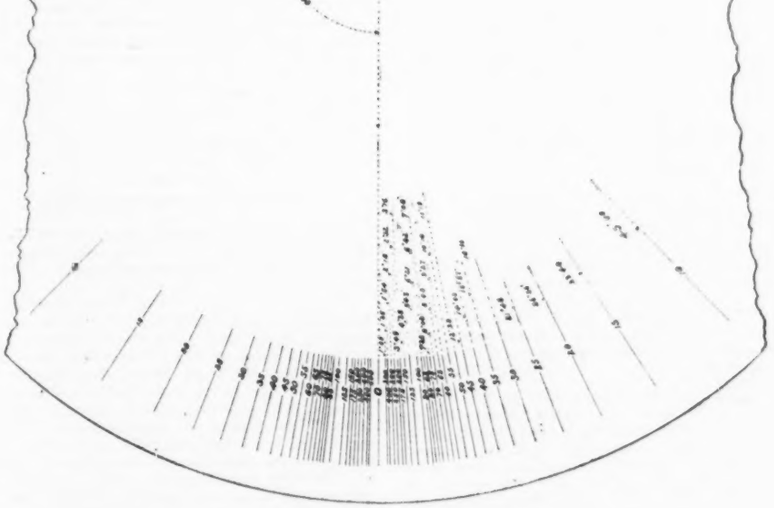
On steep slopes, covered with timber and brush, it was difficult to make much progress even with an ample corps of assistants. In an open country it was almost impossible to keep up with the transit and level party. But notes obtained in this manner are easily plotted.

I next tried a clinometer attached to a straight edge 12 ft. long. With this, field work can be done with great rapidity; but to plot the contour lines requires considerable time and patience.

I then used a slope-board, which was a semi-circular dial with an arc graduated in degrees, from the vertex of which a fine line with a weight attached was suspended extending below the graduation. A line from the vertex to the initial point of graduation would be at right angles to the top or straight side of the board, so that when the top is level the line would intersect the arc at zero. By sighting along the top of the board and placing it in a plane parallel to the surface of the ground, the angle of inclination is indicated by the line of the pendulum intersecting the arc.

In using this instrument an assistant can become very expert in estimating the distance to a change in the slope where another angle can be taken, thus enabling one man to do all the work, and to easily keep up with the transit party. I consider the slope-board better adapted to the work than the clinometer, because you can take in a longer range of observation, often 400 to 500 ft., while with the clinometer attached to a straight edge laid on the ground, you would have to place it very carefully to obtain the true slope for that distance.

To make the work of plotting contours more simple, for a graduation of degrees I substituted a graduation that indicated the horizontal distance between contours. The graduation marks indicate the horizontal distance between contours of 10 ft. made by the angle of slope.



Topography Slope Board.

The initial point is marked 0.

Angles of				feet.
1° 09′	on each side of	initial point	is marked	500
1° 26′	"	"	"	400
1° 54′	"	"	"	300
2° 18′	"	"	"	250
2° 52′	"	"	"	200
3° 16′	"	"	"	175
3° 49′	"	"	"	150
4° 35′	"	"	"	125
5° 43′	"	"	"	100
6° 21′	"	"	"	90
6° 42′	"	"	"	85
7° 08′	"	"	"	80
7° 35′	"	"	"	75
8° 08′	"	"	"	70
8° 45′	"	"	"	65
9° 27′	"	"	"	60
10° 18′	"	"	"	55
11° 19′	"	"	"	50
12° 35′	"	"	"	45
14° 03′	"	"	"	40
15° 57′	"	"	"	35
18° 26′	"	"	"	30
21° 49′	"	"	"	25
26° 30′	"	"	"	20
33° 40′	"	"	"	15
45° 00′	"	"	"	10

When the top of the board is set on a plane parallel to the surface of ground, the line of the pendulum will intersect the arc at a number indicating the horizontal distance between contours on that slope. Thus an angle of 18° 26′ would read 30 ft., and if the slope extended for 200 ft., record the note $\frac{10 \text{ in } 30}{\text{for } 200}$ prefixed by a plus sign if an ascending slope, or by a minus sign if a descending slope. To plot contours from these notes is very simple. From any station the distance to the first contour is obtained by the following proportion: The vertical distance between contours is to the horizontal distance between contours as the vertical distance to the first contour is to the required horizontal distance. Thus, if we had a note $\frac{+\ 10 \text{ in } 30'}{\text{for } 200'}$ and the elevation of station is 97, we have $10 : 30 :: 3 : x$. After the position of the first contour is established, space or plot the others until the length of slope is consumed.

Although the graduations are not numbered closer than changes of 5 ft., they are placed far enough apart to read much closer on steep slopes.

A large copper cent is a good weight for a pendulum.

For any topographical instrument used to obtain the angle of slope, I would recommend the above graduation.

In conclusion, I would say that this method was adopted and used on the western division of the South Pennsylvania Railroad during the last two years of that survey. Yours very respectfully,

WM. R. HILL.

Notes, Queries and Answers.

HOW TO USE THE GRAPHIC TRAVERSE TABLE of Mr. LORINI. As a more complete answer to the query of last week we may give the following:

To ascertain the latitude and departure of a course, as N. 60° E. 15 ft., find the number 15 at the left hand side of the diagram. Follow the circular line starting at that number until it is intersected by the line of 60°, which runs from the circumference to the center of the quadrant. Through the point of intersection two other lines also pass, one vertical, the other horizontal. The height of the vertical line, as indicated by the figures on the left, gives the latitude, 7.5 ft. The distance along the horizontal line, as shown by the figures along the bottom, gives the departure, 13.0 ft.

The same operation gives the latitude and departure for a course of 150 ft. or 1,500 ft. by multiplying 7.5 and 13.0 by 10 or 100.

If the latitude and departure of an unknown course are given, the course itself can be supplied with the table.

For courses between 200 and 400 ft. long, take one half of the distance, and multiply the latitude and departure obtained by 2. Between 400 and 1,000 ft. double the distance and divide the latitude and departure by 2. This will give more accurate results than by taking the actual distance.

JOHN BEERS, City Engineer of Greenville, Darke Co., O., inquires for published data on the construction of a natural gas plant, piping, etc. In reply we would state that a monograph by Mr. CHAS. PAINE, of Pittsburg, Pa., published in February, 1887, and several reports by Mr. CHAS. A. ASHBURNER, now of Pittsburg, contain much valuable data relating to this subject. We know of no published work devoted to the detail of joints and pipe laying, and would be pleased if some of our readers could give the desired information. There is much scattered literature on the subject in our own and other periodicals.

M. F. TUTWILER, Empire, Dodge Co., Ga., wishes to purchase "blue-prints" of standard trestle-work and timber bridges. The very latest are desired; but parties requiring further particulars must address the applicant.

A correspondent asks if there is any simple and inexpensive ice machine, suitable for farm or household use, by which a probable deficiency of ice due to the present unusually mild winter may be remedied. There are a number of such machines, but we are not prepared to say which is the most suitable. If manufacturers will send information to this office, it will be duly forwarded and noted.

A correspondent asks if there are any tables published in book form similar to those in Shunk, Searles, Trautwine and Henck and generally used upon the location of railways but constructed for the Mexican or metric system. Several pocket-books contain some reference to the matter, but with a very little ingenuity no special tables are necessary. The metric unit of measure is the 20-metre chain, the stations being 10 metres, so that each chain-length covers 2 stations. A 1° curve *laid off with a chain of any length* is 57.30 times the length of that chain. With a 100 ft. chain this gives us 5,730 ft. radius. With a 20-metre chain it gives 1.5 or 0.2 times as much, or 1,146 metres; and similarly, the radius in metres for any degree of curve is given by multiplying the tabular foot radius as given in the pocket-books, by 2, and pointing off one more decimal. The 20-metre chain being 65.6 ft. long, the radius of a 1° metric curve is only 0.656 (or about 2-3) as long as a foot curve of the same degree, so, that a 10° metric curve = a 15° ft. curve nearly. This covers about all the ground that a special set of metric tables seems needed for, except the common tables for converting kilometres into miles, etc.

A correspondent calls attention to "what appears to be a contradictory statement on page 602 of The Economic Theory of the Location of Railways." In speaking of the maintenance of way expenses for assistant engines in §776 it is claimed that 'the whole cost per train mile of maintenance of way, excluding maintenance of bridges and buildings, is increased about 50 per cent. by the pusher, i. e., is as much for the pusher alone passing up and down as for the whole train passing one way.' In the next paragraph [777] the maintenance of way expenses per mile of round trip are found by multiplying those per mile of full train by 2 without taking the 50 per cent."

The correction is sound, and arose from a change in the last paragraph from 50 to 100 per cent. in order to be on

the safe side, without correcting the corresponding statement above. The last two lines of par. 776 should read (the changed words being in *italics*): "increased about 50 per cent. by the pusher *directly, and including the indirect increase due to heavier traffic may fairly be taken as in practice 100 per cent.*"

PERSONAL.

Mr. M. BECKER has been reappointed City Engineer, of Austin, Minn.

Mr. JOHN MCCOUNIFF, Division Superintendent of the Chicago, Burlington & Quincy, died recently.

Mr. CHARLES HENRY HURD, formerly Superintendent of the Michigan Central for many years, died at Concord, Mass., Jan. 26.

Mr. ARTHUR SINSEL, Superintendent of Bridges, Buildings and Water Stations on the Baltimore & Ohio, died at Wheeling, W. Va., on Jan. 24.

Mr. C. L. GOULD, formerly Chief Engineer of the Cleveland & Marietta, has gone to Chili as engineer for McArthur Bros., of Chicago, railway contractors.

Mr. J. B. CHAPIN, Division Superintendent of the Boston & Albany for 20 years, died recently at Springfield Mass., at the age of 72. He had been nearly 50 years with the road.

Mr. E. A. GRAHAM, of Utica, N. Y., who was prominently connected with the Utica & Black River road from its beginning, died at Utica, N. Y., Jan. 27, at the age of 87.

Sir FREDERICK BRAMWELL, late President of the Institution of Civil Engineers, was made a baronet on Jan. 1. He was knighted 8 years ago for his services in promoting technical education.

Mr. G. W. VAUGHAN has been appointed Engineer of the Eastern division of the New York, Chicago & St. Louis, to succeed Mr. A. W. JOHNSTON, recently promoted to be Superintendent of the division.

FRANCIS H. TOWS died suddenly of apoplexy in Washington, on Jan. 23. Mr. TOWS was for 20 years Treasurer of the Chicago, Rock Island & Pacific Ry. Co., and was also a director of the company.

Mr. E. M. FINNEY, formerly General Manager and Managing Director of the Wisconsin Central, is to become General Manager of the Chicago, Milwaukee & St. Paul when he returns from Europe next June.

Mr. C. A. HAMMOND, Assistant Secretary of the Association of North American Railroad Superintendents, will for the present assume the position of Secretary, made vacant by the resignation of Mr. WATERMAN STONE.

Mr. E. L. CORTHELL, M. Am. Soc. C. E., is engaged, on behalf of the city of New Orleans, in studying the question and formulating plans for a belt-road, union passenger depot and a Mississippi bridge in that neighborhood.

Mr. C. D. MCKELVEY, General Superintendent of the New York, Susquehanna & Western, has resigned to take the superintendency, on Feb. 1, of the Spuyten Duyvil Division of the New York Central, and of the Grand Central Station, New York city.

Mr. G. W. DICKINSON has resigned his position as Superintendent of the Montana Union, to accept a position with the St. Paul, Minneapolis & Manitoba. He will be succeeded by Mr. ROBERT LAW, Assistant General Manager of the Northern Pacific.

Mr. D. B. ROBINSON has been appointed Assistant General Manager of the Atlantic & Pacific, with headquarters in Boston. Mr. S. M. ROWE has been appointed Chief Engineer of the western division of the road, with headquarters at Albuquerque, N. M.

Mr. WM. H. BURR, formerly of the Mexican National railway, has been appointed Chief Engineer of "the French Co. of Venezuelan Railways," and leaves for Venezuela shortly. The company is reported to be a strong one with considerable important work on hand.

Mr. J. M. BARR, Superintendent of the Burlington & Northern at La Crosse, Wis., has resigned to accept a similar position with the Union Pacific, with headquarters at Omaha. J. R. HASTINGS, Assistant Superintendent and General Agent of the freight department at Minneapolis, will succeed him.

Mr. HERBERT WALLIS, of Montreal, has been appointed Mechanical Superintendent of the Grand Trunk system, with Mr. SMITH of the Northern division, as Assistant. Mr. E. K. DOMVILLE, Mechanical Superintendent of the Southern division, has been made Superintendent of the car wheel foundry at Hamilton.

Mr. CHARLES CORNER, of San Antonio, Tex., Resident Engineer on the San Antonio & Aransas Pass Ry., has been engaged to make the location, from Merida, Venezuela, down the Chama river, on the new "French Company of Venezuelan Railways." He sails on Saturday, Feb. 2, with WM. H. BURR, Chief Engineer.

Mr. J. J. BURNS, railway contractor, made an assignment at Battle Creek, Mich., on Jan. 25, with liabilities of nearly $1,000,000. The assets are mainly stock in the Battle Creek & Bay City and the Battle Creek & Goshen railways, of a face value of $1,500,000.

Mr. CHAS. L. COLBY, President of the Wisconsin Central Railway Co. and of the Wisconsin Central Co. has resigned. He is succeeded as President of the Wisconsin Central Railway Co. by his brother Mr. JOSEPH L. COLBY, and Mr. EDWIN H. ABBOTT succeeds him as President of the Wisconsin Central Co. The latter company operates the Wisconsin Central road and all the lines which make up the Wisconsin Central Co's. system.

Mr. T. W. KENNAN has been appointed Division Superintendent of the St. Louis, Arkansas & Texas, for Arkansas and Missouri, with headquarters at Pine Bluff, Ark. Mr. H. D. MILTON has been appointed Division Superintendent for Texas, with headquarters at Tyler, Tex. Mr. F. HUFSMITH, Superintendent of Transportation, has resigned, and the office has been abolished, and the offices of Master of Transportation and Roadmaster are also abolished.

Mr. ANGUS PETER MACDONALD, one of the oldest and best-known contractors in Canada, died recently at his home at Toronto, aged 76 years. Among the important works executed by Mr. MACDONALD were the Trent Valley and Tay canals, the Intercolonial Railway and Lachine canal. The estimated value of his contracts is between $40,000,000 and $50,000,000. One of his two sons, Mr. RANDOLPH MACDONALD, is now connected with the Don improvements.

Mr. JACOB TOME, the millionaire banker of Port Deposit, Md., who sometime ago set aside $500,000 to found a manual training school, has increased his gift to $2,500,000. He proposes to establish this school at once at Port Deposit, and if his wishes are carried out it will be the most complete in this country, if not in the world. Mr. TOME came from the lower ranks himself and fully understands the difficulties in the way of advance for the poor. He is 89 years of age, but hopes to live to see his charity in operation.

Mr. G. M. CUMMINGS has been promoted from Superintendent of the Wyoming division of the Union Pacific, to be Assistant General Manager of the lines west of Cheyenne, with headquarters at Salt Lake City. The duties of C. S. MELLEN, Assistant General Manager, are confined to the territory east of Cheyenne. The office of General Superintendent is abolished, and Mr. E. DICKINSON is assigned to special duties, and reports directly to the Vice President. Mr. J.M. BARR is appointed Superintendent of the Wyoming division, vice G.M. CUMMINGS promoted.

Mr. THOMAS G. SPOONER, a well known railway man, died in New York on Jan. 24 at the age of 66. He was a member of the corps that surveyed and built the New York Central & Hudson River R. R. He then went with the Erie road as conductor, and in 1853 became Assistant Superintendent of the Ohio & Mississippi. He served as General Freight Agent of the Indianapolis, Cincinnati & Chicago during the war, and from 1873 to 1879 was the General Manager of the Jacksonville, Pensacola & Mobile road. He came to New York in 1880, and at the time of his death was Night Inspector of the elevated railway system.

Mr. SAMUEL M. FELTON, late President of the Pennsylvania Steel Company, died on Jan. 24 at his residence in Philadelphia, aged 79 years. Mr. FELTON graduated from Harvard College in 1833, and began studying law, but gave that up to become a civil engineer. In 1841 he built a railway from Boston to Cambridge. He was superintendent of the Fitchburg Railroad from 1845 to 1851, when he was elected President of the Philadelphia, Wilmington & Baltimore Railroad. Mr. FELTON was appointed by Gov. ANDREW as a member of the Hoosac Tunnel Commission, and by President GRANT to inspect the Pacific railroads. He was for many years a director of the Pennsylvania Railroad.

PUBLICATIONS RECEIVED.

Bulletin of the Agricultural Experiment Station, College of Agriculture, Cornell University, IV. Published by the University, Pamphlet.

This brief record of experiments in growing corn, etc., shows very useful and careful work.

The Manual of Statistics. Railroads: Grain and Produce; Cotton, Petroleum, Mining Dividends and Production. Vol. XI., New York: The Investors Pub. Co. 8 vo. pp. 371. $2,00.

This manual is chiefly confined to financial statistics for the use of investors and speculators, but it contains no little useful information for every one.

Meter Tables, giving number of U. S. gallons for each cubic foot, from 1 to 1,000,000. By GEO. A. ELLIS, C. E. The American Frost Meter Co. publishers. Boston, Mass.

Illustrated Annual of the Duluth Daily News—1889. This is a very handsomely illustrated and well edited description of the city of Duluth, that well sets forth the salient features, advantages and resources of this enterprising city, and the annual itself reflects much credit upon its publishers. The article on the Duluth railway system is particularly full and good, and of this we shall have more to say in another issue.

American Weather.—A Popular Exposition of the Phenomena of the Weather, Hot and Cold Waves, Blizzards, Hail Storms and Tornadoes. By Gen. A. W. GREELEY, Chief Signal Officer, U. S. A. New York: DODD, MEAD & Co. 8 vo. pp. 286; 32 engravings, 24 charts, 9 tables. $2.50.

A very interesting and suggestive manual which may well find a place in every engineer's library, and which will be found instructive reading. We reserve the book for fuller notice later.

Water-Works Statistics (of British Water-Works) 1887. Edited by CHAS. W. HASTINGS. London: The Scientific Pub. Co. pp. 33.

This thin little book gives details, somewhat analogous to those in our own Water-Works Manual, of 306 Water Works in England, Scotland, Wales and Ireland, of which poor Ireland has the enormous aggregate of *one*. We shall review the information contained in the work extensively hereafter in connection with our own forthcoming statistics of American water-works, which are of vastly greater interest in all respects than the British works.

Illustrated Catalogue of the Bowden Power Brake Co. Baltimore, Md. 4to. pp. 60, 14 plates.

This is the catalogue of a new competitor for the favor of the railway public as respects automatic air brakes for both freight and passenger use. It is carefully gotten up in the same general style as the well known Westinghouse catalogue and shows the nature of the apparatus in much detail. The prices put upon the equipment are:

Locomotive equipment	$250
Locomotive and tender brake	$150 to $250
Passenger car brakes	$ 50
Freight car brakes	$ 30

The results of a recent test of the apparatus are recorded in another column.

SOCIETY PROCEEDINGS.

Engineers' Club of Philadelphia.—Record of regular meeting, Jan. 19, 1889. Vice-President ARTHUR BEARDSLEY in the chair. Twenty-nine members and one visitor present.

Mr. SAMUEL T. WAGNER read "Some Notes on Steel Works in the South of Scotland." The paper consists of a series of notes taken at the time of visiting the Forth Bridge, the bridge works of Messrs. WM. ARROL & Co., the Parkhead works of Messrs. WM. BEARDMORE & Co., and the works of the Steel Company of Scotland at Glasgow, in March, 1888. The principal points described of the Forth Bridge are the construction of the compression tubes, their assembling and machinery for drilling them, and the ingenious methods of power hydraulic riveting done on the bridge during erection; rivets being driven by special machinery where they could not even be driven by hand. The hydraulic machinery for bending the plates, especially the main plates for the tubes (8 x 3 ft. x 1¼ ins. thick), where a pressure of 3,584,000 lbs. was exerted on the top die by 4 24-in. hydraulic cylinders, was of great interest. The planers were all of a very heavy pattern, and the work held down by hydraulic cylinders. The tool moved, cut both ways, and had a feed of about $\frac{1}{16}$ of an inch. The different kinds of paint offered for the final coat of the bridge are applied on sections of the main tubes and marked with the maker's name and date of application for purposes of testing.

At the bridge works of Messrs. WM. ARROL & Co., the whole force was finishing the Hawkesbury bridge, which was sublet to them by the Union Bridge Co., of New York. The three lowest bids for this work were from American firms on American designs, the lowest being the Phœnix Bridge Co., for £280,000, while the Union Bridge Co. bid £327,000, and DAVID MUNROE, of Melbourne, made a bid of £702,384. The substructure designed by the Union Bridge Co. was of special merit.

The drilling plant for working steel at this shop is very similar to that at the Forth Bridge, and it is all done on the assembled members, so that no reaming whatever is necessary. A cold saw 24 ins. in diameter, and making about five revolutions a minute, is a very useful tool. It has cutting teeth like a miling machine. After drilling, the work is torn apart and reassembled for the riveter, which works by hydraulic power. In making the new Tay Bridge, the chords, 300 ft. long, were assembled and drilled in one length.

The Parkhead Works have a steel plant of 8 open hearth furnaces, whose capacities range from 10 to 27 tons, casting into a straight pit. Ingots weighing 69 tons have been cast. Twelve large hammers are busy on all kinds of heavy forgings. The rest of the plant consists of one 9-in. mill, one 13-in. mill and three 20-in. mills, together with a plate mill producing nearly every section. The testing department has two simple lever machines, and as many as fifty pieces can be broken and recorded in an hour. About 24 test pieces, averaging ⅝ of an inch in thickness, can be prepared in a double rotary, within 40 minutes from the time they are put in the machine, two

cuts only being taken. The pieces are all taken from the finished section.

The works of the Steel Company of Scotland have 14 open hearth furnaces of 15 tons capacity each, arranged in a straight line, and pouring by means of a traveling ladle into one common casting pit. There are two plate roll trains, with reversing engines, and roll bodies 10 ft. 9 ins. long. A plate 72 ins. wide, by 1¼ ins. thick, by 44 ft. long, was lying on the floor. A special cam press for making quenching tests very rapidly was of special notice.

T. M. CLEEMANN, *Secretary pro tem.*

Illinois Society of Engineers and Surveyors.—The fourth annual meeting was held at Bloomington, Ill. Jan. 23, 24 and 25.

The address of the President, C. G. ELLIOTT, on "Drainage Areas and their Drainage Discharge" was especially applicable to the drainage of large tracts of agricultural land. S. F. BALCOM gave an account of the progress of work on the Cairo bridge over the Ohio river. Prof. I. O. BAKER in his paper entitled "A Plea for Brick Construction in Engineering," set forth the advantages of brick for culverts, abutments, piers, pavements, and other engineering structures as compared with stone, giving the results of tests and experience.

S. S. GREELY, of Chicago, read an article on "The Metric System," giving its advantages and outlining a method for its adoption. E. A. HILL, of the C. I., St. L. & C. Ry., Cincinnati, O., gave a supplementary paper on the Nichols Hollow Culvert, in which he gave the result of a year's experience with the culvert which was fully described in the Report of the Society for 1888, mentioning the effect of the extreme high water, the proper size for a culvert draining that area, the durability of the method of paving, and a reply to some criticisms on the design.

Prof. A. N. TALBOT, of the University of Illinois, gave a general description of the different methods of sewage disposal, outlining the values of each as applicable to the different conditions of the cities of Illinois. S. A BULLARD, of Springfield, described the new source of the water supply of that city, including the method of construction and situation of the horizontal duct which, is located through the water stratum. D. W. MEAD, of Rockford, read a paper on "Sources of Water Supply and their Development." The mining papers were "A New Mexico Coal Mine," by GEO. W. RICHARDS, Carthage, N. M., and "Mining Plant," by A. C. BRANCHER of Lincoln.

The paper on "The Methods of Measuring and Computing Earthwork," by E. L. MORSE, of Cazenovia, caused considerable discussion on the desirability of the different methods and the percentage of error allowable. A. H. BELL, of Bloomington, gave a description of the municipal engineering features of the city. This and the paper on Lake View by JOHN W. ALVORD are a part of a series descriptive of the engineering features and methods in the cities of Illinois, the first of which, on Rockford, was given last year.

The following papers were also read: "Subdivision of Sections," HENRY C. NILES, Tuscola; "Levee Construction," E. J. CHAMBERLAIN, Pittsfield; "Electric Lighting in Small Cities," J. H. GARRETT, Chicago; "The Causes of Railway Accidents," S. F. BALCOM, Champaign; "Specifications," W. D. CLARK, Springfield; "By what Rules of Law are Course, Distance, and Area Governed in the Subdivision of the Government Sections?" Z. A. ENOS, Springfield; "Pavements," G. W. WIGHTMAN, Peoria; "A Park Topographical Survey," E. I. CANTINE, Bloomington; and "The Exterior Boundary of Townships," F. HODGMAN, Climax, Mich.

The topical discussions included interesting items. On the subject of the premium systems for excellence in track work, CHARLES HANSEL, Chief Engineer of the Wabash Railway, gave a description of the system in use on his road, which was followed by the experience and methods of others. Thickness of corner-stones for box culverts, cost of track laying, necessary strength and size of culvert pipes, and the best system of superintending work, were among the several topics discussed. The exhibit of drawings was large and varied. Visits were made to the shops of the Chicago and Alton Ry., and to the city water-works and electric light plant. The famous Bloomington brick pavement, some of which has been in use for 14 years, was also inspected.

The following were elected officers for the ensuing year: President, C. G. ELLIOTT, Gilman; Secretary and Treasurer, A. N. TALBOT, Champaign.

The Michigan Engineering Society.—At the session of Jan. 23, at Lansing, Mich., a paper on "Brick Street Pavements" was read by Prof. C. E. GREENE, of Ann Arbor, which sketched at length the qualities desirable for a paving brick, and gave in detail the results of the experiments in Nashville, Tenn., Youngstown, O., Allegheny City, Pa., Bloomington, Ill., Jacksonville, Ill., Cincinnati, O., Peoria, Chicago, Galesburg, Decatur, Champaign and Springfield, Ill., New Orleans, La., Wheeling, W. Va., Steubenville, O., and Camden, N. J.,—towns that are now testing brick paving. "The disadvantages of brick pavements," said the professor, "arise from lack of uniformity in the material, and the liability of incorporating in the pavement brick of too soft and porous structure, which crumble the first winter under the action of frost. When laid on a solid foundation the advantages are cheapness, smoothness, cleanliness, freedom from noise and sanitary excellence as non-absorbent. Taking all things into consideration, it is superior to macadam, wood, and, for a maximum traffic of three tons, is also superior to granite.

The general durability of brick paving was vigorously combatted by Engineer MCLOUGHLIN, of Detroit. Solidity and elasticity were the two things desired in a pavement, and he believed that if a cheap pavement was desired, wood blocks were preferable, and if a good pavement of higher price, asphalt was the thing. He was not prepared to state that Trinidad asphalt would not prove the standard pavement of the future.

During the two sessions papers were read from WM. B. COATS on "Kalamazoo's Water Supply," ISAAC TELLER, on "What a Special Agent Saw in Oregon and Nebraska," Prof. W. H. PETTEE, on "Building Stones," and H. C. REASSONS on "A New Method for Longitude."

Association of North American Railroad Superintendents.—At a meeting of the Association held in St. Louis, Sept. 19, 1888, the Committee on Roadway was authorized to offer a prize of $50.00; open to any railway man, "for the best essay or short treatise on track-work, the proper care of roadway, and the most approved methods of building the superstructure of a railway" (not including grading or bridge-work), "accompanied by such reliable estimates of cost as can be drawn from actual experience. The paper should also discuss the subject of systematic track-inspection and the plan of giving premiums, showing the practical workings of such a system, with its advantages and drawbacks, if any."

As a slight guide in the preparation of such a paper, the following synopsis of topics is suggested, not necessarily to be adopted, or only such of them to be developed as each writer's time, experience, or inclination may allow:

I. Methods of drainage for roadbed, slopes, cuts and tunnels. Protection of slopes and banks from caving and gullying.
II. Cattle-guards. Road-crossings. Fencing.
III. Ballasting and tamping. Methods of prolonging life of ties. Keeping up track in winter and early spring.
IV. Remarks on track-laying, spiking, spacing rails, joint-fastenings, etc. Maintenance and alignment of track on tangents and on curves.
V. Experience with frogs and switches, also "slip-switches" and yard work.
VI. Examples of erroneous theories and faulty practice.
VII. Protection of road against water encroachment of river, sea or lake. Dykes and revetments.
VIII. General rules and regulations to govern work done by maintenance-of-way department.
IX. Systematic inspection of road, daily, monthly, quarterly and yearly. The premium system.
X. Extraordinary repairs: Washouts, broken rails, earthwork slips, road settlement in soft ground, repairs of track broken up by derailments.
XI. Examples from personal experience of noteworthy incidents or achievements in road-work, remarkable occurrences, accidents (not caused by trains). Illustrations of ingenuity in overcoming difficulties or in the use of temporary expedients in quickly repairing damage to roadbed or track.
XII. Reliable estimates of cost, both of regular routine work (construction or maintenance), and of special jobs or work of peculiar difficulty.

Each paper should be signed with a motto or assumed name, with direction for re-mailing to the care of some railway officer, giving correct address, to which manuscripts will be returned, except the one securing the prize, such paper to be retained for publication, when the writer's true name will be requested.

Papers should be forwarded to the Secretary's office, 350 Atlantic Avenue, Boston, Mass., not later than April 10, 1889, though competitors who may find themselves unable to complete their papers before April 10 will write to the Secretary, stating probable time of completion, and in such case the Committee may consider it advisable to grant an extension of time. Such letter should be signed with the motto or assumed name, as above directed.

C. A. HAMMOND, *Secretary.*

RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

Port Jervis, Monticello & New York.—On Jan. 25 the last rail was laid on the extension from Huguenot to Summitville, on the New York, Ontario & Western Railroad, a distance of 19 miles. The line will be open for traffic on Feb. 5.

Canada & St. Louis.—The failure is announced of the J. J. Burns Construction Co. which has just completed the Battle Creek & Bay City division of this road from Goshen, Ind., to Battle Creek, Mich. According to a dispatch to the New York *Times*, the heaviest creditors are JOHN FITZGERALD of Lincoln, Neb., President of the Irish National League, for $425,000; E. C. NICHOLS of Battle Creek, who is also President of the railroad company, for $85,000; the Joliet Steel Company, for $225,000; and floating debts amounting to over $150,000. The first two are for money loaned and advanced to the construction company by two of its members, and the last item comprises the pay rolls and local debts of the company.

By its contract the company was to build the road for $16,000 per mile in mortgages and bonds and $20,000 in stock and the local bonuses. This was payable as fast as the road was completed, and, as 90 miles are already built, the company has therefore come into the possession of about $1,560,000 of bonds and $1,750,000 of stock. The bonds, however, have been hypothecated to the first three-named creditors.

The railroad and construction company officials say that their troubles all arose from their inability to play their bonds and stock as fast as the demands of their extension of work required. If they could have realized from these, they affirm that they would have been all right, and they still express confidence that they shall yet be able to carry out their original plans.

Cornwall & Lebanon.—Surveyors are at work near Reading on the proposed extension from Lebanon to Reading. It is reported that the Philadelphia & Reading managers are laying side tracks at Reading to obstruct the entrance of the new road to the city.—Surveys are in progress for a line from Cornwall to Lancaster, and are to be made also from Cornwall to Middletown.

New York, Ontario & Western.—The Wharton Valley Ry. from New Berlin to Edmeston, N. Y., is to be opened for traffic at once. It is proposed to extend it to Richfield Springs, 18 miles further.—It is stated that the Scranton & Forest City road, which is now under way between Scranton and Carbondale, Pa., is being built in the interest of this company.

Williamsport & Binghamton.—At the annual meeting of this company held at Williamsport, Pa., Jan. 22, F. M. WARD, Newton, N. J., was elected President; E. J. STERLING, New York, Treasurer; CHAS. F. CAMP, Williamsport, Pa., Secretary; A. P. BERTHOUD, General Manager, and F. P. JAMES, Chief Engineer; with offices at Williamsport. The estimated cost of the road is $3,000,000.

Grand Trunk.—It is stated that the company intends to aid the proposed Ottawa & Vaudreuil Ry., and that construction is to begin early in the spring.

Delaware, Lackawanna & Western.—The company's report for the year 1888 shows gross earnings, $43,352,422, an increase of $5,386,566 over the previous year; operating expenses, $33,546,135, an increase of $2,852,135; net earnings, $9,686,288, an increase of $534,431. Interest, betterments and rentals amounted to $6,186,004, leaving a balance for stock of $3,500,262, or equal to 13½ per cent. The amount expended for betterments during the year was $967,605.

Evansville & Richmond.—It is very difficult for the projectors of a new railway line to please everyone. The people of Columbus, Ind., who have just voted the company $75,000, are now said to be very indignant because the new road is to run through Seymour, a rival commercial center.

Pennsylvania.—The following statement of the results of the company's operations has been issued:

	1888	1887
Gross earnings	$58,172,077	$55,671,313
Operating expenses	39,331,152	37,086,585
Net earnings	$18,840,925	$18,584,728

It is reported that the company intends to build 10 miles of new line near Logansport, Ind., to avoid the heavy grade on the present line from Logansport toward Chicago. Right of way is said to be already secured for the road. The present line will be kept up for the use of east-bound trains.—F. E. Gwinner, of Pottstown, Pa., has the contract for the Unity branch of the Southwest Pennsylvania road.

Johnsonburg.—This Pennsylvania road, under construction in the interest of the Western New York & Pennsylvania Co., will be completed in about a fortnight. The road is expected to furnish a heavy coal traffic to the main line, and $30,000 will need to be expended on the Clermont branch to fit it for the increased traffic.

Columbus, Lima & Northwestern.—The contract for 120 miles of this road, from Columbus to Defiance, O., has been let to STEPHEN G. CLARKE, 1525 No. Halsted St., Chicago, who is now purchasing material and letting sub-contracts.

Louisville, New Albany & Corydon.—Rails have been purchased for the four-mile extension to King's Cove quarries of this Indiana road. M. J. O'CONNOR of Corydon, Ind., is President.

Projects and Surveys.

Evansville & Tennessee.—Incorporated in Indiana by L. M. RICE, J. C. GORDON, C. YOUNG, A. S. MARKS and J. E. WILLIAMS, of Indianapolis, Ind.

Coudersport, Hornellsville & Lackawanna.—

COUDERSPORT, Pa., Jan. 24, 1889.

EDITOR ENGINEERING NEWS:—The locating surveys have been completed for this line, which is to run from Coudersport, Pa., *via* Colesburg, Gold and Genesee Forks to the State line, there connecting with the Hornellsville, Coudersport & Lackawanna, which is to run *via* Greenwood to Hornellsville, N. Y., a total distance of 55 miles. The line surveyed is very favorable as to grades and curvature, and work will be light. No local aid has been secured. The company was incorporated in November, 1888. W. H. WICKHAM, of Hornellsville, N. Y., is Chief Engineer. D. C. LARRABEE, *President.*

Charlestown & Jeffersonville.—The citizens of Charlestown and Jeffersonville, Ind., have a project on

foot to build a line of railroad between those two places. It is proposed to use the old Sandusky roadbed, and the cost of construction would be very small. THOMAS A. GRAHAM, of Wichita, Kan., and JOHN C. ZULAUF, of Jeffersonville, are interested.

Union.—This company has been chartered in Pennsylvania with a capital of $50,000, to build a railroad from the Edgar Thomson Steel Works in Braddock township to Street's Run, a distance of 5 miles. The Directors are J. WAINWRIGHT, W. E. JENNINGS, E. B. HAWKINS and G. T. RICHARDS.

South Sudbury & Worcester.—It is reported that a survey is to be made for a railroad between South Sudbury and Worcester, Mass., about 18 miles. H. A. HANCOX, of Hudson, Mass., is Chief Engineer.

Schuylkill & Lehigh.—Surveys are reported in progress for this road, which is to run from a point in the western part of Schuylkill Co., through Cressona and Tremont, to the Lehigh Valley R.R., a distance of 60 miles. E. N. FRISBIE, of New York, is President and JAMES A. THURSTON is Treasurer.

Washington & Great Falls.—Incorporated in Maryland to build a line of railway from Great Falls to a point on the boundary between Maryland and the District of Columbia. Among the incorporators are M. F. MORRIS, M. W. BEVERIDGE and WM. S. THORNFIN of Washington.

Findlay Belt.—It is reported that work will begin on this line soon. The citizens of Findlay, Ohio, are asked to do the grading. JOSEPH RAMSEY, Jr., Chief Engineer of the Cincinnati, Hamilton & Dayton R. R., is President.

Jersey City & Western.—A charter has been filed in New Jersey for the construction of a railroad from a point on the westerly line of Communipaw, south of the Central Railroad in Jersey City, to Avenue F, between Astor and Murray streets, Newark, a distance of 6¾ miles. Among the incorporators are REON BARNES, Middletown, N. Y.; F. R. BALDWIN, Jersey City; A. L. VOORHEES, Newark; and F. W. CONRAD, of Perth Amboy. The capital stock is $200,000.

South Bethlehem & Utica.—

ALBANY, N. Y., Jan. 29, 1889.

EDITOR ENGINEERING NEWS:—This company is now being organized to build a railroad from Wemple's station, on the Albany branch of the West Shore R. R., through Bethlehem, Peoria and Gallupville to Schoharie, thence *via* Central Bridge, Sloansville and other points, not yet determined, to Utica. Sixteen miles of the route have already been surveyed. The average grade is 55 ft. per mile and the maximum grade is 68 ft. per mile. Six miles of the line already surveyed runs along the eastern slope of the Helderbergs, and three miles of this is on a ledge of rock from 100 to 150 ft. wide. W. H. SLINGERLAND is Chief Engineer.

WM. H. SLINGERLAND, JR., *Assistant Engineer.*

SOUTHERN—Existing Roads.

St. Augustine & South Beach.—

ST. AUGUSTINE, Fla., Jan. 24, 1889.

EDITOR ENGINEERING NEWS:—The St. Augustine & South Beach Ry. is completed and in operation from the east shore of the Matanzas river, opposite St. Augustine, to Anastasia, 2 miles. The road bed is completed 3 miles farther, to South Beach, and track will be laid within 3 months. It is projected to extend south to Matanzas, a distance of 14 miles. MILO S. CARTTER is President and A. L. KNOWLTON is Chief Engineer. O. G. SHANDS.

Jacksonville, Mayport & Pablo.—During 1888 track was laid on this road from Arlington, Fla., to Mayport and Burnside Beach, 20 miles. H. D. MING is Superintendent.

Cumberland Valley.—About 15 miles have been graded on the extension from Martinsburg to Winchester, Va. The open winter has been very favorable for the graders, and they will complete their work sooner than was anticipated.

Chattanooga, Rome & Columbus.—Surveys are in progress under S. Z. RUFF for the extension from Carrollton, Ga., south to Columbus.

Louisville Southern.—J. B. Serpell & Co. of Louisville, Ky., have received the contract for the extension from Lawrenceburg, Ky., east four miles.——It is reported that the Versailles & Midway Railroad and the Woodford Railroad have been formally consolidated with this line.

High Point, Randleman, Asheboro & Southern.—About 125 hands are now at work on this North Carolina road.

Ohio Valley.—It is reported that this company has purchased the Clarksville & Princeton branch of the Louisville & Nashville. If this proves true, the company will not be likely to build the extension from Princeton to Hopkinsville, for which surveys have been made and local aid obtained.

Louisville & Nashville.—Reports still circulate that C. P. HUNTINGTON'S Kentucky Central is likely to become a part of the Louisville & Nashville system.

Chesapeake & Nashville.—The managers of this company are said to be considering plans for the completion of this Kentucky road as originally projected.

Norfolk & Western.—Chief Engineer W. W. COE is at work on the surveys for the West Virginia & Ironton Ry., near the future terminus at Ironton, O.

Savannah, Griffin & North Alabama.—The suit entered by minority stockholders of this company against the Central Railroad & Banking Company of Georgia, which holds the bonds and a majority of the stock, has been decided in favor of the defendant.

Kanawha & Ohio.—It is thought that the Chesapeake & Ohio company will soon acquire control of this road, extending from Charleston, W. Va., to Corning, O., 126 miles.

Roanoke & Southern.—The contract for grading this road from the Virginia State line to Walnut Cove has been awarded to Breen, Feely & Newby. Tracklaying is in progress on the division already graded from Winston, N. C., north.

Empire & Dublin.—The Empire Lumber Co., of Empire, Ga., are obtaining right of way for the extension of their 15 mile logging road to Dublin.

Richmond & West Point Terminal.—A suit has been brought at Richmond, Va., to cause the Attorney General of the State to bring an action for the annulment of the charter of this company on the ground that in acquiring control of competing lines and purchasing stock in different companies it has exceeded its powers. A preliminary hearing is to be had on Feb. 9. The general opinion is that the unknown complainants who have brought the suit have no grounds for their action, and that their motive in so doing was to injure the reputation of the Terminal Company.

Roanoke & Craig.—This road is to run from Eagle Rock, Va., on the Richmond & Allegheny R. R., up Craig's creek to Newcastle, and thence to a point on New river with a branch to Roanoke. The Sears Construction Company, which has taken the contract for the whole line, has opened an office at Eagle Rock, Va.

West Virginia Central & Pittsburgh.—At the recent annual meeting in Baltimore, Md., it was stated that the western extension has been completed to Parsons, on the west side of the Cheat river, 14 miles. Grading is in progress on the remaining 23 miles, and it is intended to have the road completed to Elkins, on the Tygart's Valley river, by June 1.

Alma & Little Rock.—This company proposes to extend its road from Maxton, N. C., north to Spring Hill, and south to Rowland. J. B. WILKINSON, Alma, N. C., is President and Superintendent.

Louisville Southern.—

LEXINGTON, Ky., Jan. 29, 1889.

EDITOR ENGINEERING NEWS:—Morrison, Young and Walker have signed the contract to build 13 miles of road between Lexington and Versailles, Ky., to be completed by July, 1889.

They will start work Feb. 1 with a large force of men, and push the road through as soon as possible.

MORRISON, YOUNG & Co.

Projects and Surveys.

Mississippi River & Mexican Gulf.—

WESSON, Miss., Jan. 24, 1889.

EDITOR ENGINEERING NEWS:—This road is to run from Natchez, Miss., *via* Union Church, Caseyville, Wesson, Monticello, Columbia, Purvis and Augusta to Mobile, Ala., about 300 miles. The route has been surveyed 20 miles east to Monticello. The line as projected will run through a fine farming and grazing country and through rich white pine and cotton growing regions. Right of way has been guaranteed; $62,000 cash aid has been secured at Wesson, and other aid is promised from the towns along the route. Contracts for work will probably be let by March 1, 1889, tracklaying will begin this summer, and part of the line will be opened for traffic in the fall. The company was incorporated in 1884. J. P. RICHARDSON is President.

LUTHER SEXTON, *Sec. and Gen. Mgr.*

Macon, Tuscaloosa & Birmingham.—

MACON, Miss., Jan. 23, 1889.

EDITOR ENGINEERING NEWS:—This line is projected to run from Macon, *via* Tuscaloosa, Ala., to Birmingham, 120 miles, crossing the Tombigbee river near Fairfield, and the Black Warrior river at Foster's Ferry. The line has been surveyed from Macon to Tuscaloosa, 66 miles. Work is light, grades are easy, and there is a very small amount of curvature. Right of way has been secured for 55 miles and other local aid is promised. The company was incorporated in 1884. R. C. PATTY, of Macon, is President and H. P. FARRAR, of Jackson, Tenn., is Chief Engineer. THOS. J. O'NEIL, *Secretary.*

Monongahela River.—A press report states that work will begin on this West Virginia road without delay, and that the road will be completed the present year. The road is to run from Fairmont to Clarksburg, about 35 miles, connecting with Senator CAMDEN'S system of narrow gauge railroads which will be changed to standard gauge. This will give a system of about 125 miles of roads which will reach the Baltimore & Ohio at Fairmont, opening up the Monongahela valley, and affording connection between the Monongahela Coal & Coke Co.'s coal fields and the Baltimore & Ohio R. R. The Monongahela Coal & Coke Co., organized in connection with the above road, has secured 40,000 acres of coal lands along the proposed route and will build 500 coke ovens near Fairmount during the coming summer. Ex-Senator JOHNSON N. CAMDEN is at the head of the enterprise and Senator GORMAN, of Maryland, and E. W. Clarke & Co., of Philadelphia are interested.

Dover & Statesborough.—It is reported that work is to be begun on this Georgia road, which is projected to run from Dover to Statesborough.

Hawesville & Pellville Mineral.—A press report states that this company is about to commence surveys on their proposed route.

Holston.—A company has been organized in Tennessee to build a line of railway from Knoxville to a point on the Holston River near Boyd's Ferry, a distance of about 50 miles. Among the incorporators are J. W. FLETCHER, J. F. PRESTON, C. M. PUCKETT and J. K. DORAN, all of Knoxville.

Pensacola & Memphis.—A party of engineers, with N. M. BRANDON in charge, left Meridian, Miss., recently to begin the survey of this road. It is expected that work on construction will begin soon.

Atlanta, Asheville & Baltimore:—

ASHEVILLE, N. C., Jan. 23, 1889.

EDITOR ENGINEERING NEWS:—We are now endeavoring to form a syndicate to build this road which is to run from Atlanta, Ga., to Roanoke, Va., *via* Asheville. The route runs through one of the finest mineral and timber belts in the State. The people along that portion of the route passing through this State will give material aid—from $500,000 to $1,000,000 in county bonds, which will sell at cash, par value—and the people of Georgia and Virginia will probably aid in a similar way. We are anxious to confer with capitalists and men interested in railway matters in regard to the organization of a company and the construction of the road.

NATHAN ATKINSON, *President.*

Chattanooga Southern.—

CHATTANOOGA, Tenn., Jan. 28, 1889.

EDITOR ENGINEERING NEWS:—The Chattanooga Southern Railway is to run from Chattanooga, Tenn., *via* Cedar Grove, Ga., to Attala, Ala., about 84 miles. Ten miles of the route has been surveyed and three miles of grading is under contract. The remainder of the survey will be finished very soon. The work is easy, there being no cuts over ten ft. deep. There are two bridges and one tunnel. We have five years in which to build the first ten miles of the road. The charter members are furnishing the necessary funds for carrying on what work has been let. W. CRUTCHFIELD is President and E. F. WITTMAN is Chief Engineer. The company was incorporated Oct. 24, 1887.

J. C. HENDERSON, *Gen. Manager.*

Luverne, Andalusia & Pensacola.—

ANDALUSIA, Ala., Jan. 24, 1889.

EDITOR ENGINEERING NEWS:—We expect to commence the surveys of this road by the first of May. The road is to run from Luverne, Ala., *via* Mount Ida, Leon, Andalusia and Ferry Pass to Pensacola, Fla., 125 miles, passing through one of the finest pitch pine and agricultural regions in the South. The route is very favorable for construction, there being no large bridges or tunnels and little grading. The land along the entire route is nearly level and suscept ble of a high state of cultivation. It will afford the road a heavy traffic in agricultural products, lumber, stock, phosphate, lime and building stone. The right of way will be donated with few unimportant exceptions, and the capital stock of $200,000 will easily be taken by the towns along the route. Contracts for construction will be let by July or August. It is expected that tracklaying will begin about October, 1889, and the road will be opened for traffic about September, 1890. The company was incorporated Jan. 10, 1889. CYRUS A. O'NEAL is President. We are now negotiating for a Chief Engineer.

S. J. S. CAWTHORN, *Secretary.*

Bowling Green & Northern.—

BOWLING GREEN, Ky., Jan. 28, 1889.

EDITOR ENGINEERING NEWS:—Propositions for two separate railways were submitted to the county to-day. The Bowling Green & Northern is to run from Litchfield, Grayson Co. Ky., to Bowling Green, 40 miles, opening up a section rich in coal, iron, lime and fire clay. This road will be operated in connection with the Chesapeake, Ohio & Southwestern. J. PROCTOR KNOTT is President and M. H. CRAMP is Secretary. The Henderson & State Line is projected to run from Henderson, Ky., *via* Bowling Green to Chattanooga, Tenn. The company asks for a subsidy of $200,000 in each county, nothing to be paid until the road is finished. M. H. CRAMP, *City Eng'r.*

THE NORTHWEST—Existing Roads.

Milwaukee & Northern.—The contract for extending the Ontonagon & Brule River Railroad from its present terminus at Rockland, Mich., south to the Duluth, South Shore & Atlantic R. R. at a point 35 miles west of Champion, has been let to McIntosh Bros. of Milwaukee, Wis. The line will be 36 miles in length, and is to be completed within a year. The company is said to have secured running rights over the Duluth, South Shore & Atlantic from Champion to the junction of the Ontonagon & Brule River road.

Chicago, Burlington & Quincy.—About 1,000 hands with 400 teams are at work on the extension from Alliance, Neb., northwest, under Kilpatrick Bros. & Co., contractors.——JOHN FITZGERALD of Lincoln, Neb., has been awarded the contract for the construction of a line from Nebraska City, Neb., west to De Witt, about 55 miles.

Illinois Central.—A corps of engineers in the employ of this company are said to be at work on a branch from Central City, Ia., to Stone City and Anamosa, about 20 miles.

Chicago, St Paul & Kansas City.—The traffic department of this company will have its headquarters in the Phœnix building, Chicago, after March 1. The other offices of the company will remain at St. Paul.

Projects and Surveys.

Canada.—The projectors of the following railway lines will apply to the coming session of the Canadian Parliament for charters: A road is proposed from a point on the Canadian Pacific, near Shelby station, to a point near White Mud lake, on the Winnipeg river. Another is to run from a point on the Fraser river, in New Westminster, B. C., to a point on the International boundary line, near Semiahmoo bay. A third is projected from Durham, Ont., to Meaford; a fourth from Victoria, B. C., to some point on or near Shoal harbor and Swartz bay, North Saanich, Vancouver Island, and from points on the mainland to Vancouver, New Westminster and the International boundary to connect with the Canadian Pacific and railway systems of the United States. There is also a project for a line of railway from a point on the Kootenai river near the Toad Mountain District, B. C., north along the valley of the Columbia river to the Boat Encampment.

Yankton & Norfolk.—A press report says that the $100,000 asked by an English syndicate for building this

road from Yankton, Dak., to Norfolk, Neb., 60 miles, has been raised and is in the hands of the agent, J. F. M. PIERCE, of Yankton. He has purchased ties and rails and will begin construction as soon as weather permits.

Sioux City & Northern.—It is announced that a Philadelphia trust company, represented by L. C. TWOMBLEY, has agreed to float bonds for this company to the amount of $16,000 per mile. Local aid to the amount of $5,000 per mile has already been secured. The road has been located and the right of way obtained from Sioux City, Ia., to Flandreau, Dak., 120 miles. A traffic contract has been made with the St. Paul, Minneapolis & Manitoba company, and the road will give that system an entrance to Sioux City. JOHN HARNICK, of Sioux City, is President, and L. F. WAKEFIELD is Chief Engineer.

THE SOUTHWEST—Existing Roads

Arkansas Midland.—A charter has been granted in Arkansas to the Mississippi & Little Rock R. R. Co., to build an extension of this road from Duncan *via* Prairie, Lonoke and Pulaski counties to Little Rock, Ark., about 60 miles.

Chicago, Rock Island & Pacific.—Z. FAULKNER has just completed a survey for the proposed extension from Liberal, Kan., to White Oaks, N. M., a distance of 340 miles, and reports a favorable route for the extension. The party left Liberal Dec. 20 and surveyed their line *via* Ft. Sumpter. When and how the Rock Island managers propose to build the line is not yet made public.

San Antonio & Aransas Pass.—Tracklaying is now completed from Houston west about 30 miles, and connection with the western division at the Brazos river will soon be made.

Ft. Worth & Rio Grande.—J. P. Hughes has the contract for a 2½-mile branch to quarries near Granbury, Tex.

Denison & Washita Valley.—Contracts for grading the first section of this road have been let to D. B. Corder and to Ramey, Dodson & Sturman. W. B. MUNSON will be Superintendent of Construction, with headquarters at Denison, Tex.

Cleveland, St. Louis & Kansas City.—The force of graders at work on this road between St. Charles, Mo., and a point on the Mississippi opposite Alton, Ill., has been doubled, and the grade will be ready for the rails by the middle of the month.

Projects and Surveys.

Kingston.—Incorporated in Missouri to build a railroad from a point near Mapleton on the Peoria & Western Ry. to Kingston. The capital stock is $15,000. The incorporators are J. W. WALTERS, E. B. HALE, DAVID SMITH, B. F. RHADEHAMEL and L. C. STRAIGHT.

Mississippi & Little Rock.—Incorporated in Arkansas to build a railway from Duncan, Monroe county, through the counties of Prairie, Lonoke and Pulaski to Little Rock, a distance of 60 miles. The capital stock is $1,000,000. Among the directors are THOS. L. NELSON and WM. A. BRANNON of Little Rock.

Leroy, Topeka & Northern.—The survey of this line, which will run from Topeka to Leroy, Kan., 75 miles, is completed. S. A. MITCHELL is chief engineer.

Fort Worth Western.—A contract has been closed by which this company agree to begin construction and complete 85 miles of their road the first year on condition that a subsidy of $40,000 be raised at Fort Worth, Tex. The road is to run from Fort Worth to Albuquerque, N. M., a distance of 460 miles. The main offices will be at Fort Worth. W. H. H. LAWRENCE is President.

Central Belt Line.—

MACON, MO., Jan. 18, 1889.

EDITOR ENGINEERING NEWS:—The surveys for this road, which is to run from Macon to Bevier, a distance of 5½ miles, are finished. The maximum grade is 3½ per cent. and the maximum curve is 6°. Right of way has been nearly all obtained. Tracklaying is expected to begin sometime in July, 1889. J. A. HUDSON, of Macon, is President, and C. J. DEBOIS is Chief Engineer. The company was incorporated Dec. 18, 1888.

THEO. GARY, *General Manager.*

Louisiana, Arkansas & Northern Central.—According to all reports, the financial affairs of this company are in a somewhat precarious condition, as they are unable to pay for $130 worth of office furniture purchased in Chicago. The road as projected was to run from Moberly, Mo., south through Arkansas to Beggs, La., about 680 miles, with branch roads from Farmersville, La., to Sabine Pass, Tex., 240 miles, and from Little Rock to McAllister, I. T., 140 miles. The company claimed to have good financial backing, and to have made preliminary surveys. Mr. JOHN H. MARTIN was Superintendent of Construction, with offices at Chicago.

ROCKY MT. AND PAC.—Existing Roads.

San Pete Valley.—General Manager THEODORE BRUBACK and others have incorporated the Utah & Arizona Ry. Co. to build an extension of the San Pete Valley Ry. from Chester to Manti, Utah, 17 miles. The cost of the line and equipment—it is a narrow gauge road—is estimated at $170,000.

Carson & Colorado.—It is reported that capital has been obtained for the extension from Keeler to Mojave, Cal., and that it will be built the coming season.

Northern Pacific.—President THOS. F. OAKES is quoted as follows in reference to the proposed alliance between this company and the Wisconsin Central:

"The Legislature of Minnesota of late years and the policy of the Railroad Commissioners have disturbed our people, and a question arose whether it would not be better to move to Chicago, and distribute Minnesota business from there. The policy of the Commissioners has so affected the market that one can't raise a dollar in New York to build lines in Minnesota. We look for better treatment now, and the whole matter may blow over."

Nevada, California & Oregon.—Trains are now running to a point 75 miles north of Reno, Nev., and the line is reported nearly ready for the rails for a distance of 30 miles farther.

Denver & Rio Grande.—The contractors on the Lake City branch are finding the work in the 13-mile canon rather difficult. For a large part of the distance the walls of the canon are almost vertical, and a great amount of blasting is required to obtain a roadway.—On the extension from Glenwood Springs to Rifle Creek, 5 camps of graders have been established, and the line is to be ready for the rails by May 1.

Los Angeles & Pacific.—Contractor Spillman states that the ballasting is now completed to Santa Monica and the road is ready for traffic. It has not yet been decided, however, when the line will be formally opened.

Union Pacific.—The foundations for the Cheyenne, Wyo., repair shops have been staked out and the work on their construction is to be pushed as fast as possible.

Projects and Surveys.

Salem, Tillamook & Astoria.—Articles of incorporation have been filed in Oregon for the construction of a railway from Salem *via* Tillamook to Astoria. The incorporators are J. G. WRIGHT, J. A. MANNING and J. W. MAXWELL all of Portland, Ore.

Siuslaw & Eastern.—Incorporated in Oregon to build a railway from Siuslaw Bay *via* Eugene to the eastern boundary of Oregon. The capital stock is $1,000,000. The incorporators are A. G. HOVEY, J. A. STRAIGHT, WM. A. COX, J. M. HODSON and E. C. SMITH. The principal office will be in Lane county, Ore.

Big Horn & Southern.—Chartered in Montana to build a railway from a point on the Northern Pacific, in Yellowstone county, to a point on the line between Montana and Wyoming near the head of Five-mile creek, passing through the counties of Yellowstone, Custer and Sheridan. The incorporators are E. D. BANNISTER, PAUL MCCORMICK, W. F. SANDERS, T. C. POWER and A. J. SELIGMAN.

FOREIGN.

Mt. Vesurius.—The railway up Mt. Vesuvius, Italy, which has not been in operation for some time, is to be opened again in a few days under the direction of JOHN M. COOK, who purchased the property some time ago and has repaired it and put into a proper shape for working.

Mexico.—A railway is under construction from Chihuahua to Cusihuiriachic, a mining camp in the Sierra Madre mountains, west of the Mexican Central. It is stated that the company building it is backed by the Mexican Central and that the line will be eventually extended to Guaymas, on the Pacific Coast.—Track laying will begin soon on the Monterey & Mexican Gulf road.—Messrs. Reed & Cameron of the City of Mexico are pushing the surveys on the Mexican Southern road, which is projected to run from the City of Mexico south to a terminus on the Pacific coast at the western end of the proposed Isthmus of Tehuantepec Railway. The Government guarantees 8 per cent. interest on the investment for 15 years. The system will be nearly 1000 kilometres in extent.

RAPID TRANSIT.

Elevated Railway.—***Brooklyn, N. Y.***—The Union Elevated Ry. Co. received subscriptions last week for $1,300,000, the unsold portion of the $2,305,000 first mortgage 6 per cent. bonds, interest on which is guaranteed by the Brooklyn Elevated Railway Co. The Union elevated road is leased and operated by the Brooklyn elevated, the two roads forming one system. Of this system the Broadway section, 2.76 miles, and the lower Myrtle Ave. section, to the Brooklyn bridge, 1.85 miles, form the portion of the Union elevated road already constructed and in operation. The middle Myrtle Ave. line, 1.52 miles, and the 5th Ave. line to Greenwood cemetery, 3.10 miles, are now under construction, and when completed will give the Union Co. a total of 9.23 miles; other extensions are projected. The entire system aggregates about 11.36 miles, and when completed it will be about 19 miles.

Electric Railways.—***Westbrook, Me.*** An electric railway is projected, and Hon. C. B. WOODMAN is interested.

Hyde Park, Mass.—An electric street railway is to be built. The Thomson-Houston system will probably be used.

Geneva, N. Y.—A proposition to build an electric line is to be presented to the Board of Trustees.

Atlanta, Ga.—The Atlanta & Edgewood Street Ry. Co. has awarded the contract for the equipment of 2 miles of line with an electric system, at an estimated cost of $80,000.

Auburn, Cal.—A franchise for an electric railway has been granted to W. R. ARTHUR.

Dummy Lines.—***Rome, Ga.***—A dummy line to Kartah and Subligna is projected by Dr. J. T. ROAN, of Kartah, Ga. The distance is about 23 miles, and the cost, including 46-lb. rails, 4 cars and one or two engines, is estimated at $138,000.

Dardanelle, Ark.—The dummy line to Mt. Nebo, a distance of 4¾ miles, will be commenced March 15 and is to be completed by August. It will be 3-ft. gauge, laid with new steel rails of light section, and will be well equipped. The estimated cost is $30,000.

Denver, Col.—The Park Ry. has been opened for traffic. It is 3½ miles long, laid with 30-lb. steel rails; the Swem switch is used, it is under the control of the engineer and can be operated without stopping the train. A dummy engine built by H. K. Porter & Co., of Pittsburg, Pa., is used. J. W. STRAYER is General Manager.

Street Railways.—***Newport, R.I.***—The street railway question, which has been discussed for so long, has been finally settled, and the City Council has passed an ordinance granting the Newport Horse Railway Co. authority to lay tracks on certain streets.

Hartford, Conn.—The street railway company has issued bonds for $100,000 for the purpose of building branches to Parkville, West Hartford and East Hartford. A new company is to be organized to build lines on certain streets.

Roanoke, Va.—The Citizens Street Ry. Co. has been organized by JOSEPH H. SANDS, D. W. FLICKWIR, J. A. JAMISON and others.

Asheville, N. C.—A street railway company has been organized by NAT. ATKINSON, M. J. FAGG, J. P. SAWYER and others. Work will be commenced in the spring.

Cicero, Ill.—The Cicero Passenger Street Ry. Co. has been incorporated at Chicago, by CHAS. F. SWIGART, O. M. BRADY, THOMAS SCOTT and others. Capital stock, $300,000.

Pueblo, Col.—The Pueblo Street Railway Co. expects to build considerable extensions this spring.

Dallas, Tex.—The West Dallas Street Ry. Co. will soon commence the construction of its road.

Macon, Ga.—A scheme is on foot for the consolidation of the street railway systems, and the company owning the dummy line is negotiating for the purchase of the lines of the Macon Street Ry. Co. Major JOHN S. BRANSFORD is president of the street railway company, and A. H. FARRAR, of Kinderhook, N. Y., is president of the dummy line company.

CONTRACTING

Pipe.—***Reading, Pa.***—The following proposals for 11,600 ft. of 30-in. cast-iron pipe, 13,000 ft. of 24-in. and 100 to 200 ft. of 40-in., have been received by the Water Commissioners: Mellert Foundry & Machine Co., Reading, Pa., $25.50, $26.70, $27 and $28.27 per ton according to point of delivery; reducers, curves, branches, etc., $2.25, $2.30, $2.35 and $2.40 per lb. according to point of delivery. McNeal Pipe & Foundry Co., Burlington, N. J., $27 per ton for pipe, 2¾ cts. per lb. for branches, etc. The contract was awarded to the Mellert Foundry & Machine Co. The material is for a pipe line from the proposed pumping station on the banks of the Maiden-creek to the city.

Bellefontaine, O.—The following proposals for 127.5 tons of pipe and 6,430 lbs. of specials have been received by the Consulting Engineer, JOHN W. HILL: Lake Shore Foundry, $22.45 per ton for pipe, 2¼ cts. per lb. for specials, total $3,023.12; Ohio Pipe Co., $23.77, 2½ cts., $3,165.70; Addyston Pipe & Steel Co., $23.80, 2½ cts., $3,169.50; National Foundry Co., $23.95, 2¼ cts., $3,198.29; Dennis Long & Co., $24.25, 3 cts., $3,284.77; Ripley & Bronson, $25.50, 2.95 cts., $3,440.93; Jackson & Woodin Mfg. Co., $26.35, 2.6 cts., $3,526.80; Shickle, Harrison & Howard, $26.50, 3 cts., $3,571.65; Keating & Sheehan, $28, 3 cts., $3,762.90. E. A. Stemson, including laying, $7,310. Snyder & Williams, including laying, $4,327.—The following were the bids for laying 12-in. pipe: A. G. Snyder, 26 cts. per lin. ft., $884; Snyder & Williams, 30cts., $1,020; E. A. Patterson & Son, 33 cts., $1,122; Keating & Sheehan, 34 cts., $1,156; J. J. Rumsey, 38½ cts., $1,309.

Mankato, Minn.—The following proposals were received Jan. 19 by W. B. DAVIES, City Recorder: Lake Shore Foundry, Cleveland, O., $28 per ton for pipe, 2½ cts. per lb. for special castings; Geo. E. Downing, South Pittsburg, Pa., $29.25; Phelps & Youngren, Minneapolis, $30, 3 cts.; Russell, Boynton & Co., Minneapolis, $30, 3¼ cts.; Addyston Pipe & Steel Co., Cincinnati, O., $30, 3¼ cts.; H. P. Rugg & Co., St. Paul, $30.50, 3¾ cts.; J. M. Fisher, Allentown, Pa., $30.67; J. B. Clow & Co., Chicago, $41; Wyckoff Pipe Co., Bay City, Mich., $51. The contract was awarded to the Lake Shore Foundry.

Retaining Wall.—The following were the proposals received by the Kings County Supervisors, Brooklyn, N. Y., for the construction of a retaining wall round the reservoir of St. Johnland, L. I.; the length of the wall about 1,000 lin. ft.: Thomas McCann, $35 per lin. ft.; Edward Freel, $35.75; Harris & McGuire, $39.50; Charles Collins, $42.30.

Pier Work, Dredging, etc.—The following proposals have been received by the Docks Department, New York City: Repairing pier No. 43 (new), North River: Thomas

Hayden, $5,443; B. S. Cronin, $5,900; Gilbert Earl, $5,980; R. P. Staats, $6,700; Ranald Gillies, $6,900. The contract was awarded to Thos. Hayden.——For repairing pier No. 2, East river; O'Connell & Coffey, $9,900; Colin McLean, $10,100; B. S. Cronin, $11,450; Thomas Hayden, $13,773. The contract was awarded to O'Connell & Coffey.——For building bulkhead, dredging, etc., at the foot of Lincoln Ave., Harlem river: John W. Flaherty, 30 cts. per cu. yd. for dredging, $9,690 for bulkhead complete, 60 cts. per cu. yd. for rip-rap; Thomas Hayden, 30 cts., $9,782; $1; Walls & Van Riper, 28 cts., $10,145, 95 cts.; B. S. Cronin, 35 cts., $10,460, 95 cts. The contract was awarded to J. W. Flaherty.——For 5,000 cu. yds. of rip-rap: Brown & Fleming, 74 cts. per cu. yd.; John A. Bouker, 80 cts. Contract awarded to Brown & Fleming.——For 200 spruce piles, 50 to 60 ft. long: A. J. Murray, $5.50 per pile; Beard & Kempland, $6. Contract awarded to A. J. Murray.

Cement.—The following proposals for 500 lbs. of Portland cement have been received by the Docks Department, New York City: E. W. Fisher, $2.29 per lb.; Emile Lenz, $2.30; James Brand, $2.35; S. L. Merchant & Co., $2.37; A. C. Babson, $2.48; F. G. Brown, $2.55. The contract was awarded to E. W. Fisher.

Lead.—The following proposals for 40 tons of pig lead, delivered, have been received by the Water Commissioners, Reading, Pa.: Bard, Rebec & Co., $3.94½ per 100 lb.; J. L. Stichter & Son $3.95; D. C. Schnader & Son, $3.95; Bright & Lerch, $3.97½; Hoff & Bro., $3.99; Clendennin Bros., Baltimore, 4 cts. per lb.; W. A. Heckman, $3,225.50.

Sewers.—*Columbus, O.*—The following are the totals of proposals received Jan. 21 for the construction of a main intercepting sewer: L. C. Newson, Columbus, $460,838.61; D. F. Minahan, Springfield, O., $523,890.47; Everson & Riley, Cleveland, O., $576,264.50; Jas. W. Sullivan, Denver, Col., $715,674.71; Abbott & Cornell, Columbus, $725,963.89; Kaumacher & Fornef, Columbus, $742,394.10; Wolf & Truax, Duluth, Minn., $780,347. The contract was awarded to L. C. Newson at the following prices: stone outlet, complete, $8,767; brick sewer, 10,699 ft. of 6½ ft., $6.93 per ft.; 20 ft. of 6½ to 5½ x 6¾ ft., $6.58; 20 ft. of 5½ x 6¾ to 6 ft., $8.88; 1,125 ft. of 6 ft., $17.23; 6,155 ft. of 5½ ft., $11.63; 1,049 ft., of 5 ft., $14.28; 3,006 ft. of 4¾ ft., $20.37; 1,660 ft. of 4½ ft., $16.47; 286 ft. of 4½ ft., $10,30; 1,991 ft. of 4 ft., $10.51; 6,023 ft. of 3 ft., $10.54; 8,655 ft. of 2½ ft., $7.06; 770 ft. of 5½ x 6¾ ft. stone sewer, $73.08; 4,983 ft. of 2 ft. pipe sewer, $2.87; 550,000 brick for manholes, $13 per M.; 50 manhole frames and covers, $18 each.

Mankato, Minn.—The following proposals have been received by W. B. DAVIES, City Recorder: John Shaw, Kansas City, Mo., $16,162; J. Macdonald, Mankato, $17,996.08; Adam Jefferson, Mankato, $19,615.50; F. G. Grout & Co., Mankato, $19,755.60; Wolf & Fowler, Cedar Rapids, Neb., $20,312.08; Maloy, Dow, Kurst & Co., St. Paul, $20,817; Rockford Construction Co., Rockford, Ill., $21,576.80; Maxfield & Coughlin, Mankato, $21,899.60; Thornton & Shaw, St. Paul, $22,423.40; E. T. Sykes & Co., Minneapolis, $23,361.64; H. W. Phelps & Co., Minneapolis, $28,201.62; H. K. Fitzpatrick, Duluth, $38,658.10. The contract was awarded to John Shaw.

Jersey City, N. J.—The following proposals have been received by the Board of Works: Joseph Donohue, Jr., 90 cts. per lin. ft. for 12-in. vitrified pipe, laid, $1.25 for 18-in., $75 for each receiving basin; Thos. Cavanagh, $1.50, $2, $100; Michael Curley, $1.25, $1.75, $75; Thos. Harrington, $1, $1.25, $85; Matthew Fitzpatrick, $1.10, $1.35, $80; Wm. Kramer, 87 cts., $1.27, $80; Michael Henry and J. P. McGivney, 77 cts., $1.33, $77; Michael Shannon, $1.40, $2, $80; Thos. Cogan, 90 cts., $1.75, $90; Michael Brennan, $2.25, $2.75, $100.

Tunnel.—The West Chicago Street Ry. Co. will build a tunnel under the Chicago river near Van Buren St. It will be about 1,650 ft. long and 30 ft. wide, and work will be commenced as soon as the plans are completed and contracts let; probably early in the spring. The cost is estimated at $1,300,000 to $1,500,000. FREDERICK S. WINSTON is president of the company.

Dredging.—The following proposals for dredging in Wilmington harbor, California, were opened Jan. 19 by Major W. H. H. BENYAURD, U. S. Engineer Office, San Francisco, Cal.: Alexey W. Van Schmidt, $1.29 per cu yd. ($102,000), from railway wharf to Deadman's Id., $1.29 per cu. yd. ($127,500), outside Deadman's Id., total $229,500. Pacific Coast Dredging & Reclamation Co., 94 cts. per cu. yd., from wharf to island only, $79,900.

Stone.—The following proposals for furnishing stone and placing it in the jetty at Coos bay, Oregon, were opened Jan. 15 by Capt. W. YOUNG, U. S. Engineer Office, Portland, Ore.: Patrick O'Neil, $1.27 per cu. yd., if self-dumping scows are furnished by the Government, $1.39 per cu. yd., if bidder furnishes his own barges; O. S. Ward and Andrew L. Johnson, $1.49, $1.74; G. W. Loggie and G. A. Holt, $2.97, $3.21; F. A. Hyatt, $1.65 in bidder's own barges. The contract was awarded to Patrick O'Neil at $1.39, he furnishing his own scows.

PROPOSALS OPEN.

Electric Lighting.—For lighting the streets. GEO. W KURTZ, Winchester, Va. February 5.

Excavation and Paving.—Excavating and refilling trenches for gas mains; also for relaying pavements, prices for new and old pavement. Separate bids. Contract for one year. WM. C. ADAMS, Superintendent of Gas Works, Richmond, Va. February 6.

Bridge.—Lift bridges over the Champlain canal at Broad St., Waterford, N. Y. JAMES SHANAHAN, Superintendent of Public Works, Albany, N. Y. February 6.

Court House.—Plans and specifications on file. FRANK RICE, Chairman of Public Lands & Building Committee, Kearney, Neb. February 8.

Sidewalks.—Cement sidewalks. Specifications at the office of the City Engineer. THE BOARD OF SUPERVISORS, San Bernardino, Cal. February 12.

Flush Tanks, etc.—Cleaning and repairing flume, and building flush tanks in accordance with plans and specifications on file in the office of the Superintendent of Sewers. A. C. BOTKIN, City Clerk, Helena, Mont. February 13.

Jail.—Iron and steel work for cells, etc. THE COUNTY COMMISSIONERS, Parkersburg, W. Va. February 28.

GOVERNMENT WORK.

Stone.—Furnishing and placing stone on the breakwater at the mouth of the Saco river, Maine; and on the breakwater at Rockland, Maine. Lieut. Col. JARED A. SMITH, U. S. Engineer Office, Portland, Me. February 12.

Ledge.—Blasting and removing ledge from point of Badger's island, in Portsmouth harbor, New Hampshire. Lieut. Col. JARED A. SMITH, U. S. Engineer Office, Portland, Me. February 12.

Dredging.—In the channel off Seguines point, Raritan bay, New Jersey. Lieut. Col. G. L. GILLESPIE, U. S. Engineer Office, New York City. February 14.

Sea-Wall.—Repair of sea-wall and slope of water battery at Fort McHenry, Maryland. Col. WM. P. CRAIGHILL, U. S. Engineer Office, Baltimore, Md. February 14.

Dredging.—In ship channel leading to the harbor at Baltimore. Col. WM. P. CRAIGHILL, U. S. Engineer Office, Baltimore, Md. February 14.

Lock-Pit.—Excavating a lock-pit for a new lock at the St. Mary's Falls canal, Michigan, Col. O. M. POE, U. S. Engineer Office, Detroit, Mich. February 18.

Pier Work.—Cutting down and rebuilding superstructure of outer section south pier, Milwaukee harbor; about 400 ft. in length, according to cost. Major CHAS. E. L. B. DAVIS, U. S Engineer Office, Milwaukee, Wis. February 27.

MANUFACTURING & TECHNICAL.

Pumping Engine.—It was stated on p. 82 that the contract had been awarded for a pumping engine at Binghamton, N. Y. We are now informed that all bids were rejected, and that the Water Board will readvertise for proposals.

Well-Drilling Machine.—A new or second hand machine is wanted by J. S. NESBITT, of Rolla, Mo.

Market Prices.—***Steel Rails.***—New York, $27 @ $27.50; Pittsburg, $28; Chicago, $30 @ $30.50.

Railway Track Supplies.—New York: spikes, $2 @ $2.05; angle bars, 1.80 c. @ 1.85 c. Pittsburg; spikes, 2.05 @ 2.10 cts., 30 days; splice bars, 1.80 c. @ 1.85 c.; track bolts 2.80 c. with square and 2.90 c. with hexagon nuts.

Structural Iron.—New York: sheared plates, 1.9 c. @ 2 c.; universal mill plates, 2 c. @ 2.1 c.; angles, 2 c. @ 2.10 c.; tees, 2.4 c. @ 2.6 c.; channels and beams, 2.8 c. all sizes. Chicago: mill lots, universal plates, 2.20 c.; angles, 2.12½ @ 2.15 c.; tees, 2.45 c. @ 2.55 c.; small lots of angles, 2.35 c.; tees, 2.70 c.; beams, 3.50 for domestic. (Compiled from *The Iron Age*, Jan. 31.)

Wyckoff Pipe.—The Wyckoff Pipe Co., of Williamsport, Pa., manufactures the Wyckoff wooden water pipe, square or round, and where heavy pressure is to be sustained the pipe is strengthened by iron bands. The pipe is said to be very durable, ordinary wooden pipe having been in use at Philadelphia and other places for over 70 years, while this patent pipe, being coated with asphaltum cement on the outside, is not liable to decay. Steam pipe casing, pump tubing, etc., is also manufactured.

Creosoting.—The Wyckoff Creosoting Co., of Williamsport, Pa., has works for creosoting lumber, railway ties, poles, bridge and wharf timber, etc., with dead oil of coal tar forced into the wood at high pressure. The plant is built on improved plans, and work has already been done for the Manhattan Elevated, West Shore, and other railways, as well as for electrical companies.

Transfer Tables.—Levering & Garrigues, of Philadelphia, Pa., have a contract for reconstructing 4 transfer tables at Norfolk, Va., from single to double track.

Nut Locks.—Raffner, Dunn & Co., of Philadelphia, Pa., have recently filled orders for 10,000 Excelsior nut locks for the New York, New Haven & Hartford; 60,000 for the Savannah, Florida & Western, and 10,000 for the Georgia Central.

Cable Railway Yokes.—Messrs. Shoop & Baughman, of the Centropolis Car & Machine Works, of Kansas City, Mo., are manufacturing the yokes for the Denver Cable Ry. Co. Cars will be made in a short time.

Gauges.—The Reliance Gauge Co., of Cleveland, O., has an order for 15 of its safety water columns for the Dick & Meyer sugar refinery, Brooklyn, N. Y.; this is the fifth order from the refinery.

The Electric Street Car Motor Co. has been incorporated at Chicago, Ill., by W. S. SALISBURY, CYRUS A. VOSBURG and WM. ARMSTRONG. Capital stock, $250,000.

The Western Street Car Supply Co., has been incorporated at Chicago by M. G. HUBBARD, GEO. W. BROAS and others. Capital stock, $200,000.

Street Railway Cars.—The Newburyport Car Mfg. Co., of Newburyport, Mass., has built some of the cars for the electric line of the West End Street Ry. Co., Boston. There are 5 incandescent lights on each car, 3 inside and 1 on each platform.

The Laclede Car Co., of St. Louis, Mo., has an order for 60 cable cars for the St. Paul City Railway Co., of St. Paul, Minn. They will be fitted with an improved grip apparatus.

J. M. Jones & Sons, of Troy, N. Y., have an order from the West End Street Ry. Co., of Boston, Mass., for 50 open cars and 75 closed cars. This firm built 5 of the new cars on the 23rd St. line in New York.

The Lewis & Fowler Mfg. Co., of Brooklyn, N. Y., is building some open cars for the 8th Ave. line of New York.

Second-Hand Street Railway Cars.—The bobtail cars which have been abandoned by the 23rd St. line, New York, have been purchased by Mr. R. MARTIN, of New York, who will have them repaired and put in order at his works at Chester, Pa. Cars of this sort generally find their way to the smaller towns of the West and South, where the traffic is not so great but that the driver can give his attention to making change, etc., in addition to his regular duties.

Street Sweepers.—The Brooklyn Railway Supply Co., of Brooklyn, N. Y., which makes a specialty of sweeping machines and snow ploughs for street railways, is building a large track-sweeping machine for exhibition at the Paris Exposition this year. The company has designed a rail sweeper which is especially adapted for electric roads; a revolving broom, operated by one of the car axles, cleans all snow or dirt from the surface of the rail.

The Fox Solid Pressed Steel Co. is erecting works at Joliet, Ill., to manufacture articles by the process patented by Mr. SAMPSON FOX, of England.

Steel Works, Etc.—James P. Witherow & Co., of Pittsburg, Pa., are building a Bessemer steel plant, with a daily capacity of 300 to 400 tons per day, for the Chester Rolling Mills, Chester, Pa. The company is also building blast furnaces at Bessemer, Ala., for the Bessemer Iron & Steel Co.; at Steubenville, O., for the Jefferson Iron Works, and at Roanoke, Va.

Railway Shops.—The Southern Pacific will build extensive locomotive and general shops at East Los Angeles, Cal., where 60 acres of land have been purchased.

The Union Pacific will build shops at Cheyenne, Wyo., at a cost of between $400,000 and $500,000. Work will be begun very soon.

The Ohio & Mississippi is building shops at Washington, Ind., at a cost or $200,000. They will be completed by March.

Construction Companies.—The Crescent City Construction Co., of Chicago, Ill., has been incorporated by E. I. LAMB, THOS. E. DIXON and E. A. BRYAN. Capital stock, $50,000.

The Brazoria Construction Co., of Brazoria, Tex., has been incorporated by H. MASTERDON and others.

The Reynolds & Henry Construction Co., of Joliet, Ill., has been incorporated by CHAS. H. TALCOTT, J. A. HENRY and JULIUS W. FALK. Capital stock, $500,000.

Tanks.—The Memphis Cotton Seed Oil Co., of Memphis, Tenn., has awarded to W. E. Reynolds, formerly with the Union Iron Works, of Chattanooga, the contract for 10 tanks, 30 x 32 ft., with iron roofs.

Gas Plant.—R. D. Wood & Co., of Philadelphia, Pa., are building a gas holder and a set of purifiers for the Gate City Gas Light Co., of Atlanta, Ga.

A Pig Iron Combination.—The proposed movement to form a general agreement among the furnaces to restrict the output until prices have been restored, is described as follows in the *Iron Trade Review*, of Cleveland, O., by GEORGE H. HULL, of New York, the originator of the scheme. "The American Pig Iron Storage Warrant Co. is organized under the general manufacturing laws with a capital of $1,500,000, and possesses none of the features of a trust pool. It is organized to develop and secure improved methods and economies in the production, storage, transportation, distribution, handling and sale of pig iron. Its operations are not confined to any one section of the country. It is similar in its plan and features to the storage warrant system of Great Britain, which has been in successful operation there for many years. This company went into operation in November last, and has already formed connection with many of the largest furnaces in the United States."

Pipe Plant.—A new invention for rolling pipe by hydraulic machinery is said to have been tested at Sharon Pa., with satisfactory results.

Iron for the Navy.—The Union Iron Works, of San Francisco, Cal., have a contract for 30 tons of boiler plate iron for the monitor *Monadnock*, at the Mare Island navy-yard. The contract price is $10,870.

Railway Material.—The Potomac Lumber Co., of Elk Garden, W. Va., has built 3 miles of track, using a 25-lb. steel rail, and will build 17 miles more in the spring.

Mills & Storie, of Florence, Ala., want about 4,000 ft. of 48 lb. rails, second-hand.

The Arcadia Phosphate Co., of Arcadia, Fla., wants to purchase light second-hand rails and a light engine.

The Mississippi River & Mexican Gulf Ry. Co. wants steel rails, locomotive, pile driver, dump cars, and tools for railway construction. Work will be begun in March. LUTHER SEXTON, of Wesson, Miss., is General Manager.

Street Sweeper.—A hand or horse-power street sweeper is wanted. R. J. MCKELVEY, of Rochester, N. Y.

Hoisting Engine, Pump, etc.—The St. Clair Coal Co., of Ragland, Ala., wants a 20 H. P. hoisting engine, pump, 2½-in. to 3-in. pipe, and 2 boilers, 50 and 30 H. P.

Locomotive Works for Sale.—The land, buildings and plant of the Hinkley Locomotive Co. will be sold on the premises, 439 Albany St., Boston, Mass., on Feb. 7, by S. HATCH & Co., of 9 Congress St., Boston, from whom all particulars may be obtained.

The Johnson Co. is the new name of the Johnson Steel Street Rail Co., of Johnstown, Pa.

Dump Car.—A new automatic dump car has been brought out by C. W. Raymond, of Dayton, O.

Car Notes.—The Gilbert Car Mfg. Co., of Troy, N. Y., has turned out 10 passenger cars for the New York Central.

The Pullman Car Co., of Chicago, Ill., is building a train of vestibule cars for a special fast service between Omaha, Neb., and San Francisco, Cal., over the Union Pacific and Southern Pacific.——The works are also building 700 freight cars for the Cleveland, Columbus, Cincinnati & Indianapolis.

The Litchfield Car Works, of Litchfield, Ill., have an order for 200 box cars for the Cincinnati, Indianapolis, St. Louis & Chicago. They are of 40,000 lbs. capacity, and are fitted with the Wagner door and the American continuous draw-bar.

The Indianapolis Car Works, of Indianapolis, Ind., have an order for 250 cars for the Cincinnati, Hamilton & Dayton.

The South Baltimore Car Works, of Baltimore, Md., have orders on hand for 400 cars, most of them for the Richmond & Danville and the Baltimore & Ohio. During 1888, there were 1,605 cars built of 9 different classes for 7 roads. The works have a capacity of 12 cars per day.

The Terre Haute Car Works of Terre Haute, Ind., have an order for 400 freight cars for the Cleveland, Columbus, Cincinnati & Indianapolis.

The Lehigh Car Mfg. Co., of Stemton, Pa., has recently shipped a number of cars for transporting iron ore, to the Juragua Iron Co., in Cuba.

The Wabash will purchase 3 postal cars, and the receiver has been authorized to spend $10,500 for the purpose.

The New Haven & Derby has ordered new passenger and freight cars for the equipment of the new Derby extension.

The Chesapeake & Ohio has ordered 100 tube-iron freight cars.

Locomotives.—The Rhode Island Locomotive Works, of Providence, R. I., have an order for 10 freight engines for the New York, New Haven & Hartford; cylinders, 18 x 24 ins. They will be built to the designs of Mr. HENNEY, Locomotive Superintendent of the road.——The passenger engine exhibited at the recent exposition at Augusta, Ga., has been purchased by the Georgia Central.

The Baldwin Locomotive Works, of Philadelphia, Pa., are building 2 new engines for the Mears Ry. Co., of Michigan.——They are also building 2 motor engines for the Portland & Vancouver Ry. Co., which operates a dummy line at Portland, Ore.

The Manchester Locomotive Works, of Manchester, N. H., are building a ten-wheel freight engine for the Concord road.

The Schenectady Locomotive Works, of Schenectady, N. Y., have turned out 10 freight engines for the New York Central, and have an order for 6 engines for the Cleveland, Columbus, Cincinnati & Indianapolis.

The Dickson Locomotive Works, of Scranton, Pa., are building 28 engines for the Georgia Central; an improved form of Laird guide is used, with a lower bar of wrought iron, and a wide upper bar of cast-iron. The engines were designed by Mr. BLACKWELL, the Locomotive Superintendent of the road.——The works are also building 4 engines for the Delaware & Hudson, and 1 for the Normandale Lumber Co.

H. K. Porter & Co., of Pittsburg, Pa., have made several shipments recently to different parts of the country, and to the Argentine Republic and United States of Colombia.

The Richmond Locomotive & Machine Works, of Richmond, Va., are completing 4 ten-wheel engines for the Georgia Pacific; cylinders 19 x 24 ins., weight in working order 106,000 lbs. About 6 or 8 smaller engines are being built. During 1888, 36 engines of various styles and sizes were built. The works are being enlarged with the view of increasing the output, and a number of new tools have been ordered from the Niles Tool Works and Bement, Miles & Co. W. SIMPSON is Superintendent.

The Western New York & Pennsylvania has turned out an engine from its Olean shops.

The Carolina Central has turned out a second engine from its works at Laurinburg, N. C.; cylinders 16 x 24.

The Lake Shore & Michigan Southern has placed orders for 15 freight engines, 3 passenger and 7 switch engines.

The New Haven & Derby has ordered 5 engines for the new Derby extension.

The Long Island road has 11 engines for sale. Address L. F. BRINGHAM, Purchasing Agent, Long Island City.

The Toledo, Peoria & Western is building a heavy freight engine at its shops at Peoria, Ill.

BRIDGES AND CANALS.

Viaducts.—*Rileyville, Va.*—The Edge Moor Bridge & Construction Co., of Wilmington, Del., has the contract for a viaduct 1,200 ft. long for the Shenandoah Valley road.

Denver, Col.—A bill has been introduced in the State Legislature to appropriate $50,000 to aid in the construction of the 14th St. viaduct.

Chesapeake & Ohio Canal.—President GAMBRILL has directed the Division Superintendents to begin work at once on the repairs, as it is intended to let the water in on March 15.

River Improvement.—The Black river, Michigan, is being surveyed by CHAS. DANGER. This is in connection with the project of dredging the river to a depth of 15 ft.

Harbor.—The Brazos River & Channel & Dock Co. has awarded the contract for the construction of the harbor at the mouth of the Brazos river to G. Wilke, of Houston. The work includes about 1,250,000 ft. of jetty work, and the contractor has sublet contracts to R. H. Downey, of Houston, for brush for the mattresses at $100,000; and to Byrne & Jones, of Galveston, Tex., and Lake Charles, La., for 4,000,000 ft. B. M. of lumber and piling, at $65,000. The work will be commenced shortly, and will be under the supervision of Mr. E. L. CORTHELL, M. Am. Soc. C. E.

Bridge Notes.—*Wilmington, Vt.*—A bridge contract has been awarded to the Vermont Construction Co., of St. Albans, Vt.

Peekskill, N. Y.—Quarrying is reported to be in progress for the granite for the piers of the Highland suspension bridge.

Tonawanda, N. Y.—Bonds for $10,000 for the construction of a bridge have been sold at $106.57 per $100.

Syracuse, N. Y.—It is proposed to replace the present Crouse Ave. bridge over the Erie canal with a lift bridge.

Avondale, N. J.—The draw of the Passaic River bridge has been placed in position, and the bridge is expected to be opened early this month.

Philadelphia, Pa.—The question of building a bridge over the Schuylkill river at Walnut St. will be considered by the 3d District Survey Committee.

Roanoke, Va.—The city proposes to issue bonds for $36,000 for the construction of 3 bridges over the Norfolk & Western tracks.

Lynchburg, Va.—The Richmond & Danville Ry. Co. has awarded the contract for an iron bridge to the Edge Moor Bridge & Construction Co., of Wilmington, Del.

Riverton, Va.—The Shenandoah Valley Ry. Co. has completed a 5 span iron bridge over the Shenandoah river.

Chattanooga, Tenn.—The Hamilton county court has approved the issue of bonds for $200,000 for building a bridge over the Tennessee river at Market St.

Frankfort, Ky.—The Secretary of War has notified the city that the old wooden bridge over the Kentucky river must be raised, as it is too low for boats to pass under it. It has stood for 60 years.

Saginaw, Mich.—The contract for the Flint & Pere Marquette bridge over the Saginaw river has been awarded to the Smith Bridge Co., of Toledo, O. The draw span will be 190 ft. long, carried on a masonry pier, and there will be 2 approach spans of 130 ft. each.

Detroit, Mich.—The Lake Carriers' Association, at a meeting held at Cleveland, O., adopted resolutions in opposition to the proposed Detroit River bridge.

St. Paul, Minn.—It is proposed to build a bridge to carry Edgerton Ave. across the Phalen creek valley. The cost is estimated at $30,000.

Kansas City, Mo.—The Kansas City & Terminal Ry. Co. proposes to build a railway and highway bridge across the Missouri river at Quindaro if the county will vote bonds for $200,000. The Board of Trade has approved the bill which the company will present to the legislature.

The Stanislaus River bridge on the Stockton, Fresno & Southern Ry. will be built by the American Bridge & Building Co., of San Francisco; this company has contracts for 12 bridges for the same road, at an aggregate cost of $150,000. F. HOMER is Chief Engineer of the railway.

Canada.—Mr. PERLEY, Chief Engineer of the Dept. of Public Works, at Ottawa, has reported to Sir HECTOR LANGEVIN that the bridges Attorney-General MARTIN proposes to erect over the Assiniboine will not interfere with navigation.

ELECTRICAL.

Electric Light Notes.—*New Rochelle, N. Y.*—The Board of Trustees has made a contract with the electric light company for 70 lights at 35 cts. per night each.

Glens Falls, N. Y.—Electric light is proposed; $300 have been voted and $200 more are required.

Medina, N. Y.—It is proposed to put in the electric light.

Montgomery, Ala.—The gas company has increased its capital stock to $200,000 and has changed its name to the Montgomery Light Co. An electric light plant will be put in.

Tuscumbia, Ala.—The electric light company will put in a Thomson-Houston plant. J. LIGON is president of the company.

Tuscaloosa, Ala.—W. A. JETER, of Macon, Ga., is interested in an electric light project.

Amite City, La.—A local company will put in an electric light plant.

Aberdeen, Miss.—The electric light is now in operation. There are 25 Thomson-Houston arc lights, for which the city pays $6,500. Incandescent lights are to be put in the stores and offices.

South Evanston, Ill.—The Western Electric Co. has a contract for electric lighting, at $6,475. There will be 40 lamps.

Burlington, Ia.—The Electric Light & Power Co. has received a contract for 1 year from Feb. 15; the city will pay $100 per light per annum for 50 arc lights.

St. Louis, Mo.—Proposals will be received until Feb. 28 for lighting the northern and southern districts for 10 years from Jan. 1, 1890. The bids are to be for arc lights of 2,000 c. p. each, or incandescent lights of 30 c. p. each, for streets and public places, and of 2,000 c. p. and 16 c. p. each, respectively, for public buildings.

Helena, Mont.—The Helena Steam Power & Lighting Co. bid as follows for lighting the entire city: $17.50 per month per light for 40 to 50 lights, $16.50 for 60 to 79, $16 for 80 to 100. The Citizens Light Co. bid $18 per light per month for arc lights of 1,200 c. p.

North Yakima, Wash. Ty.—A franchise for an electric light plant has been granted to THOMAS HOWLETT and M. ESHLELMAN. The plant is to be in operation by May 1.

Ashland, Pa.—The following proposals for electric lighting for the streets of the borough have been received by FRANK BENTZ, Town Clerk: Ashland Gas Light Co.; each arc light 2,000 c. p., Thomson-Houston system, lights to burn all night and every night; $125 per light per year. Edison Illuminating Co., Ashland; for 5,000 c. p. incandescent light, distributed in lamps of not less than 50 c. p., the city to put up poles and lines at its own cost; $2,500 per year. The contract was awarded to the Ashland Gas Light Co. for one year from Feb. 1.

Lockport, N. Y.—A mass meeting was held Jan. 25 to further consider Mayor OLIVER's proposition that the city furnish its own electric light. The report of the committee appointed to visit other cities having plants of their own was read and adopted; it was decidedly in favor of the city owning the plant. A resolution was passed recommending the introduction of a bill in the State Legislature authorizing the Common Council to issue 4 per cent. bonds for $30,000. The Council will invite proposals for a plant.

Consolidation.—The Westinghouse Electric Co. and the U. S. Electric Lighting Co. have consolidated their interests and will operate for mutual benefit. The latter company has a large business and owns a factory at Newark, N. J. The former company has about 143 central stations, with a total capacity of 250,000 lamps of 16 c. p., and controls several subsidiary companies. The two companies together have a very large manufacturing capacity, and control about 700 patents on electrical inventions. The combination represents a united capital of about $10,000,000.

WATER AND MUNICIPAL.

Artesian Wells.—*Cardiff, N. Y.*—About 15 wells are to be put down, and surveys are now being made.

Uniontown, Ala.—The contract for the artesian well has been awarded to DANIEL DULL, of New York, at $5 per ft.

Alexandria, La.—The well put down by the Artesian Well Works Co., of New Orleans, has been accepted by the city, and the water will be piped for a domestic supply. The flow is 15,000 galls. per day.

Dixon, Ill.—The well is now down 1,180 ft. and is flowing 100 galls. per minute. It is being put down deeper.

Saguache, Col.—The first artesian well in Saguache Co. that has struck water is on the Zeagler ranch, 18 miles southeast of the city. Water was reached at a depth of 286 ft. and rises to the surface.

Wichita Falls, Tex.—An artesian well is projected. W. O. OSGOOD is interested.

What Cheer, Ia.—An artesian well is being put down; it is now 1,100 ft. deep and has no flow yet. Upon the success of the well depends the question of putting in water-works.

Water and Sewerage.—*Fort Robinson, Neb.*—The contract for all materials and labor for water and sewerage system, and for plumbing, has been awarded by Major WM. B. HUGHES, U. S. A., Omaha, Neb., to S. E. Felton, of Omaha, at $8,992.66.

Fresno, Cal.—The following proposals for furnishing and laying 5,000 ft. of No. 16 sheet iron 6-in. water service pipe, 1,400 ft. of No. 16 sheet iron 4-in. pipe, and 700 ft. of 2-in. standard black wrought-iron screw pipe, were opened Jan. 14, by W. B. DENNETT, City Clerk: M. McDonald, San Bernardino, Cal., $4,499; C. D. Vincent, San Francisco, $5,000. The contract was awarded to M. McDonald. All other bids, for water for flushing sewers for sewage disposal, etc., were rejected.

Filter.—The Greensboro Water Co., of Greensboro, N C., will put in a filter, but has not decided as to the kind to be adopted.

Greenbush, N. Y.—The engineers to the Board of Sewer Commissioners have presented their report of the work done during the past year. The report describes the topography of the district and the details of the system, and gives the details of work on each of the 6 sections, with contract prices and totals. The smallest pipe is 10-in. diameter, with 6-in. house connections; there are also 12 and 15-in. pipes and a brick sewer 32 x 48 ins. Man-holes are placed about 400 ft. apart and catch-basins wherever necessary. Flush tanks, with the Von Vranken patent syphon, are placed on all dead ends; the capacity is 425 galls., and they are intended to empty once in 24 hours, the water being discharged in 50 to 60 seconds. Work was commenced in November 1887, and completed by September, 1888. The total length of sewer laid is 7½ miles, exclusive of branches to catch-basins. The average cost per foot is as follows: labor, 80 cts.; material, 80 cts.; engineering, 11 cts.; administration and sundries, 3 cts.; total, $1.75 per ft., or $9,240 per mile. The works have been examined and favorably reported upon by HORACE ANDREWS, C. E., of Albany, on behalf of the Sewer Commissioners. The engineers were Messrs. Landreth & Fitzgerald, of Schenectady, N. Y. The contractors were as follows: Material—Sections Nos. 1, 2 and 3, Charles Millar & Son; Nos. 4, 5 and 6, Carpenter & Woodruff; Labor—Section No. 1, Van Vranken & Clement; No. 2, John McEncroe; No. 3, M. E. Dunn; Nos. 4, 5 and 6, Adam Miller.

Water Works.—***Massachusetts.***—Springfield. The proposed bill for a new main to Ludlow has been defeated in the council.

New York.—East Randolph. The water-works question is again under discussion.——Waterford. Supt. DENNIS reports that 73,387,000 galls. of water were pumped during 1888.

Pennsylvania.—Lebanon. The Lebanon Water Co. has purchased Stoever's dam, to the northeast of the city, and will lay pipes at once to take an additional supply for the city.

Virginia.—Wytheville. The city has decided to build water-works. For particulars address the mayor.

West Virginia.—Morgantown. The Union Improvement Co. will put in water-works, taking a supply from springs in the mountain.

North Carolina.—Tarboro. Water-works are to be built. For particulars address the mayor.

South Carolina.—Spartanburg. The pipe-laying is now in progress. The water will probably be turned on in March.

Georgia.—Waycross. H. S. Haines has applied for a water-works franchise.——Griffin. A franchise for water works has been granted to the Griffin Electric Light & Water Co.——Cartersville. The Jeter & Boardman Water & Gas Association, of Macon, Ga., will commence work shortly on the water-works.

Alabama.—Troy. The National Water Supply Co., of Cincinnati, O., will put down wells by the Wagner process and will furnish a supply of 1,000,000 galls. per day.——Gadsden. The Gadsden Water Co. will extend its mains.

Mississippi.—Natchez. A proposition to build water-works has been made by J. A. JONES, of St. Louis, Mo.

Tennessee.—Newbern. Water-works are projected. For particulars address the mayor.

Kentucky.—Pineville. Three miles of pipe have been laid, and the reservoir is completed; the supply is taken from a mountain stream.

Ohio.—Bellefontaine. Proposals for pumping plant and boilers have been received from the Buffalo Steam Pump Co., of Buffalo, N. Y.; Gordon Steam Pump Co., Hamilton, O.; Deane Steam Pump Co., Holyoke, Mass.; Knowles Steam Pump Co., New York; Holly Mfg. Co., Lockport, N. Y.; National Iron Works; Keating & Sheehan and Armstrong Bros.

Illinois.—Staunton. The water-works dam is nearly completed.——Chicago. A serious break in the 36-in. main on Chicago Ave. occurred recently.

Wisconsin.—Whitewater. The Whitewater Water-Works Co. has been incorporated by J. R. GRAY, C. E. GRAY and G. A. FARWELL. Capital stock, $80,000.——Eau Claire. The Eau Claire Water-Works Co. has long endeavored, by means of filters for the Chippewa river water, driving wells and other means, to secure a supply of good water, but its efforts have not been successful. It is now proposed to run a main 2 or 3 miles north from the present pumping station, to Wheaton springs, Chippewa Co., whence it is believed a supply of 6,000,000 galls. daily would be available; the present consumption is about 1,000,000 galls.

Minnesota.—Mankato. The city has awarded contracts for plant for the water-works as follows: J. C Quinn, Mankato, 2 boilers of 80 H. P., $2,350; Holly Mfg. Co., Lockport, N. Y., Gaskill horizontal compound pumping engine, $8,250, also 15 hydrants; Lake Shore Foundry Works, Cleveland, O., pipe at $28 per ton.

Montana.—Helena. The city has signed the contract authorizing the Woolston Water Co., to furnish the city with water.——Anaconda. The Anaconda Water Co. has been incorporated by JAMES P. HAGGIN MARCUS DALY, J. R. TOOLE, WM. THORNTON and A. L. KEMPLAND.

Texas.—Ennis. The city has purchased 200 acres of land for a reservoir, to cost about $4,000.

Colorado.—Pueblo. The Water-Works Trustees have decided to build new works 2 miles west of the city, on the Arkansas river, at a cost of $200,000.

Oregon.—Portland. The bill to authorize the Portland Water Co. to issue bonds for $1,500,000 for the purpose of bringing a supply of water to the city from Bull run, will probably be favorably reported upon.——East Portland. The East Portland Water Co. has received a large compound pumping engine from H. R. Worthington, of New York.

California.—Gilroy. It is proposed to issue bonds for $50,000 at 5 per cent. for 20 years, to put in cast-iron mains and to put the water-works in good condition. The works were built in 1872.——Santa Cruz. The city water bonds have been subscribed for, $48,000 being taken in one day; they are 5 per cent. bonds for $500 each.

Utah.—Salt Lake City. The Committee on Water Supply, in its annual report, recommends that steps be taken at once to secure an additional supply. The total cost of the system has been $110,000.

Canada.—St. Lambert, Que. A water supply is contemplated; and it is proposed to obtain the same from the water-works of Longueuil, which have a surplus pumping capacity.

Albion, N. Y.—The artesian water supply developed by Bassett Bros., of Buffalo, has proved very successful. In all the wells the water rises to a height of about 1 ft. above the ground, or 2 ft. above the surface of the creek into which the overflow runs. The water maintains a uniform temperature of 45° F. and is pure and soft, although most of the water in the locality is hard. The works have been in operation since Oct. 1, 1888.

Sewage Purification.—At Toronto, Canada, experiments have been made to test the feasibility of purifying the city sewage by filtering it through charcoal before it is discharged into the bay.

Shreveport, La.—The Shreveport Gas, Electric Light & Power Co. has been granted a franchise authorizing it to manufacture and distribute light and power by means of gas, electricity and steam.——The Shreveport Gas Co. has a contract for 33 arc lights for street lighting and for lighting the public offices with incandescent lamps.

Water Bonds.—The Water Committee has awarded the issue of bonds for $100,000 as follows: Oregon Fire & Marine Insurance Co., $10,000 at $1.05; L. & I. White, $50,000 at $1.06¼; American Fire Insurance Co., of Philadelphia, Pa., $40,000 at $1.05 and accrued interest.

Street Cleaning and Garbage Removal.—The following proposals have been received by the Board of Public Works, Jersey City, N. J.: Michael Collins, $2,000 for removing garbage, $12,000 for removing ashes, $10 per mile of streets cleaned; Henry Byrne, $1,250, $15,000, $13; Joseph Maillie, $1,300, $17,000, $12; Van Keuren & Son, $3,725, $11,775, $10.50; Thos. Cavanaugh, $4,000, $17,000, $15.

Hydraulic Power in New York.—The New York Hydraulic Power Co. recently applied to the city for permission to lay its mains through the streets, but the permission was not granted.

Gas Works.—***New Rochelle, N. Y.***—The Board of Trustees has made a contract with the New Rochelle Gas Light & Fuel Co. for 100 street lamps at $25 per year each.

Morristown, N. J.—The Common Council has made a contract with the New York & New Jersey Globe Gas Light Co. to light the town.

Harrisburg, Pa.—The Jeanette Gas Co., of Westmoreland county, has been incorporated by J. A. CHAMBERS, H. S. MCKEE and WM. P. JONES, of Pittsburg. Capital stock, $25,000.

Cedartown, Ga.—Gas works are to be built. Capt. W. W. SEAY, of Rome, Ga., is interested.

Cartersville, Ga.—The Cartersville Improvement, Gas & Water Co. has purchased a site for its works and has received pipe; the works are to be completed by May. HIRAM BLAISDELL is the General Manager.

Raleigh, N. C.—The Raleigh Gas Co. has been incorporated. Capital stock, $100,000.

Tuscaloosa, Ala.—Gas works are to be built at a cost of $20,000. W. A. JETER, of Macon, Ga., is interested.

Water Power.—The project for utilizing the power of the Lachine rapids, 7 miles from Montreal, has been revived. M. D. BARR is interested. It is proposed to convey power by electricity.——The Assiniboine Water Power Co., of Winnipeg, Manitoba, is negotiating with the city authorities with regard to ceding certain of its privileges to the city. A. MOFFATT is Secretary.

St. Louis, Mo.—On Jan. 24 it was found that water was passing through the walls between settling basins Nos. 1 and 2, and the water was drawn off. The break was found to be under the walls, in the brick and concrete floor, which had been badly cracked. The new works will not be completed any too soon. The four basins now in use can handle comfortably 20,000,000 galls. per day, and send it to the service mains in tolerably fair condition; but they are compelled to take and furnish more than that amount now, and last summer they handled 40,000,000 galls. per day; next summer 42,000,000 or 43,000,000 galls. will be required. A drill is being used to sound for a location for the 6 settling basins, which will be an important part of the Chain of Rocks plant. They will have a total capacity of 100,000,000 galls. The total estimated cost of the new works is nearly $4,000,000, of which $1,300,000 are already appropriated.

Water Storage for Rochester, N. Y.—The report of the committee of the Chamber of Commerce, which was appointed to consider the matter of water storage in the upper Genesee valley, has been presented, and recommends the construction of a dam across the gorge at Mount Morris. With a dam 114 ft. high, there would be a reservoir extending 11 miles up the river and having a storage capacity of 8,000,000,000 cu. ft. Investigations have been made by JOHN BOGART, State Engineer, and by Messrs. JAMES B. FRANCIS, J. T. FANNING and CLEMENS HERSCHEL, as engineering experts for the committee. The committee has been directed to prepare a memorial to the Legislature asking for an appropriation of $5,000 to be expended by the State Engineer in securing observations and statistics of the rainfall, evaporation, flow of water, etc., and in making a survey of the site of the proposed dam and reservoir.

Special Reports of Water-Works Construction.

Cambria, Pa.—

JOHNSTOWN, Pa., Jan. 24, 1889.

EDITOR ENGINEERING NEWS:—The Morrellville & Cambria Borough Water Co. expects to have works in operation by June 1, 1889. It has a capital stock of $40,000, and has issued $20,000 in bonds. No engineer has been employed as yet. The officers are: JOHN DOWLING, J. J. STRAYER, and JOHN KURTZ. They are now ready for contractors to start on the dam. JNO. C. RYAN.

NORFOLK, Va., NAVY YARD, Jan. 23, 1889.

EDITOR ENGINEERING NEWS:—The Government is at present laying 4 and 6-in. water mains in this yard, with the expectation of ultimately connecting with those of the Portsmouth Water Co. GEO. BURNS, *Commissioner.*

We have received the following information regarding the Fort Riley, Kan., water-works, from G. W. PEARSONS, of Kansas City, Mo.

Fort Riley, Kan.—

The works were built by G. W. PEARSONS and JOHN DWYER, of Kansas City, Mo., for the United States, and after due trial were accepted Jan. 15. The plans were prepared by Prof. J. B. JOHNSON, of St. Louis, Mo. but modified by Capt. GEO. E. POND, Asst. Quartermaster, U. S. A.

The supply is from eight 6-in. Wagner steamed wells from 50 to 65 ft. deep, penetrating a gravel deposit from 20 to 30 ft. in depth. The water is of excellent quality, and the supply so ample that a continued drain of 600,000 galls. per day lowers the ground water but about 1 ft. The 1,000,000-gall. compound non-condensing pump was furnished by the Deane Steam Pump Co., Holyoke, Mass. The pump pit is 18 by 26 by 15 ft. deep, admitting, besides the new pump, the one formerly used for the supply of the post. There are two 5 by 15 ft. boilers furnished with a Wainwright heater of 75 H. P. and the usual accessories. There are 22,300 ft. of 8, 6 and 4-in. pipe, from the Chattanooga (Tenn.) Foundry & Pipe Works, with 20 Beaumont fire hydrants, 8 White hydrants reset, and 16 Chapman valves. The post buildings are in accordance with the topographical requirements of the ground, irregularly dispersed over plateaus of 125 to 175 ft. elevation. The reservoir is on the highest adjacent elevation, which is about 300 ft., giving a sufficient pressure for fire protection to the entire post; and being on a bare hill is in view for many miles in all directions. Its conical tin roof forms a prominent landmark of interest from its being within a fraction of a mile of the geographical center of the United States. It is of stone, supported by earth embankment. Capacity 500,000 galls.

DECATUR, Texas, Jan. 19, 1889.

EDITOR ENGINEERING NEWS:—I am about to enlarge my water-works system, and have placed my order for the tank, engines and pipe with the P. M. & I. Co., Fort Worth, Tex. Water will be pumped from a well to a 36,000-gall. tank, by a Cook artesian pumping engine, of 72,000-gall. capacity. Mains will be laid all over the city and fire protection obtained. The new works will be completed about March 1, 1889. Population of town, 3,000.

A. R. WHITEHEAD, *Owner.*

ASOTIN, Wash. Ter., Jan. 16, 1889.

EDITOR ENGINEERING NEWS:—The Asotin Water-Works Co. will begin the construction of works in the spring. Water is to be taken from Asotin creek through a small ditch 1½ miles long, already constructed. President, E. BAUMEISTER; Secretary, H. E. BENEDICT; Treasurer, GEO. W. BAILEY. Present population, 300.

ASOTIN WATER-WORKS CO.

GOLDSBORO, N. C., Jan. 29, 1889.

EDITOR ENGINEERING NEWS:—The contract for the construction of water-works has been awarded to H. HUNGERFORD, New York City. Franchise to run 30 years. The city rents 52 double nozzle hydrants at an annual rental of $2,790 per year. Work to be begun in 60 days.

T. H. BAIN.